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THE PAYÛM
AND
LAKE MÆRIS

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THE FAYÛM
AND LAKE MÆRIS.



OLD LAHÛN REGULATOR.

AT THE POINT WHERE THE BAHR YÛSUF TURNS WESTWARDS INTO THE FAYÛM.

The down-stream wing of the upper regulator is seen projecting into the foreground on the left-hand side, and the Lahûn Pyramid is visible in the distance.

1914

1914

FRONTISPIECE.



THE FAYÛM AND LAKE MÆRIS.

BY

MAJOR R. H. BROWN, ROYAL ENGINEERS,
INSPECTOR GENERAL OF IRRIGATION, UPPER EGYPT.

WITH A PREFATORY NOTE BY

COL. SIR COLIN SCOTT-MONCRIEFF, K.C.M.G., C.S.I.,

And Illustrations

FROM PHOTOGRAPHS BY THE AUTHOR.

LONDON: EDWARD STANFORD,
26 & 27, COCKSPUR STREET, CHARING CROSS, S.W.

1892.

PREFATORY NOTE.

DURING the last nine years it has fallen to the honourable lot of a small band of English engineers, most of them trained in India, to effect a revolution in the irrigation system of old Egypt, and thereby materially to improve the wealth and agricultural prosperity of the country. This is not the place, nor would it be becoming on my part to tell what has been effected. We had the happy fortune to find things at their lowest ebb. We could hardly make a change without making an improvement. In all these improvements Major Robert Hanbury Brown, R.E., has from the first occupied a conspicuous place. Few Englishmen have gone through so many summer seasons as he has, in the blazing heat of Upper Egypt. For that has been his field of labour, and of that field the fertile, abnormal, neglected, quaint old Province of the Fayûm forms a part. Truly, an old world province! whose historical roll carries us back to very early days, before that venerable Sheikh Abraham had made his emigration from Assyrian Haran—a province abundantly watered, and therefore rich, and highly prized by Pharaoh and Ptolemy, Cæsar and Arab Khalif, until Mameluke misrule and Turkish brutish ignorance let it fall into decay.

It has fallen to Major Brown to help to restore the Fayûm, and he has thus obtained a very intimate knowledge of it. He is not the first author on this subject. Learned Germans and brilliant Frenchmen have already written on the Fayûm. Major Brown pretends neither to the learning of the one, nor to the brilliancy of the other, but he has, what neither one nor the other ever had, an accurate knowledge of the levels of the country. This information is quite indispensable to the hydraulic engineer, and it is strange that that distinguished Frenchman M. Linant de Bellefonds, who devoted so many years to the physical improvement of Egypt, should have been evidently without it.

(RECAP)

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Of course Major Brown could not write of the Fayûm without introducing the mystic Lake Mœris. Herodotus does not lie when he tells of the things he has actually seen, and he says he saw Lake Mœris. So it must have existed. But where was it? That is the question that has been asked from one generation to another.

In the following pages Major Brown, in simple, straightforward language, gives his opinion, and the reader may be sure that he does not talk of what he does not know. Whether his conclusions are correct or not, this account of the Fayûm is an important addition to our knowledge of the subject.

COLIN SCOTT-MONCRIEFF,
Late Under-Secretary of State, Public Works Ministry, Cairo.

LONDON, *September 1st, 1892.*

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THE FAYÛM AND LAKE MÆRIS.



INTRODUCTION.

I COMMENCED this paper with the sole object of giving a technical description of irrigation in the Fayûm Province as practised to-day, for the information of my brother officers in the Royal Engineers.

But let any one turn his face towards the Fayûm, he is sure to see the speculator's will-o'-the-wisp of Lake Mœris, which must needs be followed over the marshy borders through a tangle of theories left high and dry, until the pursuer is submerged deep beneath the waters of the lake, and has to find his way out again as best he can with a theory of his own begetting or adopting.

The question of where and what Lake Mœris was has been guessed at by many, and some of the guesses have been rather wild and regardless of the attributes which the lake of the theory must be demonstrated to have, before it can be recognised as Lake Mœris.

In the time of the early Nile tourist and historian Herodotus, about 450 B.C., there existed in Egypt an extensive lake, known as Lake Mœris, of such dimensions, levels, and geographical position, that it absorbed the surplus waters of the overflowing Nile, and afterwards gave back to the dwindling river the water it had received from it, thus becoming a regulator to diminish the excesses of the Nile floods, and to supply the shortcomings of the shrunken summer flow. The benefits resulting to the land of Egypt from such a moderator of high and low Niles were supposed to have

been great, and the idea of the possibility of restoring the boon to Egypt by the discovery of the true position of the ancient Lake Mœris has helped to increase the interest in the subject, which curiosity about one of the lost wonders of the world in the once glorious kingdom of the Pharaohs would alone have been sufficient to excite.

At the end of a long letter to Mr. Paul Ascherson about a journey in the Fayûm, Dr. Schweinfurth writes:—"It must have already occurred to you, that I, in these already much too comprehensive remarks, have kept going round about the Mœris question, like a cat round hot broth. I must guard myself from pulling unripe fruit, which in a not far future will be ripe for judgment." This was written in January 1886. Dr. Schweinfurth seemed to expect that discoveries of papyri in the ruins of Arsinoë would be made, and the riddle by them be solved. We are still waiting for the papyri.

Though the fear of picking unripe fruit may produce an unfavourable state of mind for assisting to promote discussion, it is far preferable to M. Linant's attitude with reference to this question, when he stated that "*J'ai retrouvé la véritable situation de cet ancien lac ou réservoir d'eau,*" and caused or allowed to be printed on the "*Carte Hydrographique de la moyenne Égypte, par M. Linant de Bellefonds, Paris, 1854,*" the following presumptuous and decidedly untrue statement: "*Le mémoire publié par M. Linant, sur le lac Mœris, donne tous les éclaircissements désirables sur ce point de l'histoire ancienne de l'Égypte*"!

Though more illumination has been thrown on the subject since this unfounded claim to finality was made, there still remains much information to collect about doubtful points of levels, identification of old ruined towns, and so forth, but I do not on that account consider that the fear of "too hastily confusing" the question should forbid the publication of fresh facts and speculations thereon, so long as the door is not slammed in the face of those who prefer to give their support to other theories.

I will briefly state the order, and reasons for the order, in which I have arranged the different parts into which this paper is divided.

I have described the "*Fayûm of To-day*" first, as a conception of its condition in the past must of necessity be founded on a knowledge of its condition in the present.

Next I give the statements made by the ancient travellers, as it is upon them that the ideas, of what Lake Mœris was, are based.

I then proceed to try and dispose of theories which I consider erroneous, so as to clear the way for a more correct view; or at least to expose some of the errors of statement which might mislead others into accepting or forming wrong notions on the subject. Next I give the views that I have adopted, and point out what support they have from others, and discuss M. Linant's objections to the views favoured.

Then I have endeavoured to sketch the history of the Fayûm—

- (1) Before it became Lake Mœris.
- (2) As Lake Mœris.
- (3) While it was undergoing the process of being transformed from Lake Mœris to what it is to-day.

And lastly, I have added a few remarks about the possible future of the Wadi Raiân, and the effect upon the Fayûm of a more abundant supply of water in consequence of the construction of storage reservoirs now under consideration.

I have made use of all previous writings on the subject that I could lay hands on. Mr. Cope Whitehouse kindly lent me his papers and showed me where to get others. Mr. Flinders Petrie has also given me what information I applied to him for. The maps and levelling of the Fayûm, made under the direction of Lieut.-Col. J. C. Ross, C.M.G., late Inspector-General of Irrigation in Egypt, have naturally been invaluable aids to the study of the subject. Sir Colin Scott-Moncrieff, late Under-Secretary of State for Public Works, Egypt, has also given me his views on some points raised in this paper, and I have taken advantage of them. Miss M. Brodrick has most kindly assisted me in the correction of the proofs, and in other matters connected with the publication of this paper. Ali Bey Borhan, Chief Engineer of the Fayûm, and Monsieur A. Pini, in charge of works, have assisted me by collecting information and obtaining levels that were wanting.

Finally, I wish to lay claim to no originality in the views adopted. What I have aimed at in this paper is to work those views out, and to go more thoroughly into them than has hitherto been done, thereby making a contribution to the discussion of an unsolved problem, interesting alike to Engineers, Archæologists, and Classical Scholars.

As the metrical system is in use in Egypt, all dimensions and quantities

are given throughout this paper in metres and cubic metres, and distances in kilometres.

1 metre	..	..	..	..	=	3·2809 feet.
1 square metre	..	..	..	..	=	10·7643 square feet.
1 cubic metre	..	..	..	..	=	35·3166 cubic feet.
					=	220·097 gallons.
8 kilometres	..	..	..	..	=	5 miles (approximately).

Discharges are given as so many cubic metres per day of 24 hours.

1,000,000 cubic metres a day	..	=	11·5741 cubic metres per second.
		=	408·9775 cubic feet per second.

Areas are given in feddans, which is the Egyptian acre.

1 feddan	..	..	..	..	=	4200·8333 square metres.
					=	1·038 acre.

R.L. signifies "reduced level," or the level referred to mean sea-level :—
e. g. "at R.L. 25·00" means that the spot, to which the figure relates, is 25 metres above mean sea-level; and "R.L. — 40·00" means 40 metres below mean sea-level.

A contour is the line running through all the points which are at the same level above or below mean sea-level.

An Egyptian pound, L.E., = $1\frac{1}{3}$ English pound, £.

CHAPTER I.

THE FAYÛM OF TO-DAY.

Position of the Fayûm with reference to the Nile Valley.—About 50 miles south of Cairo, a branch line leaves the Upper Egypt line of railway and goes west. After crossing the Basin land of the Nile Valley, it enters the western desert, and after a short ascent and somewhat longer descent, it reaches the station of Edwah in the Province of The Fayûm.

This province is the most remarkable and interesting of all the provinces of Egypt. It is an oasis surrounded by desert, being separated from the Nile Valley by four to twelve kilometres width of the Libyan Desert, and being connected with it by a narrow neck of cultivation marking the gap in the Libyan Hills, by which the Bahr Yûsuf enters the Fayûm.

Depressions connected with the Fayûm.—Forming part of this province, and included in it administratively, is the Gharaq Basin or depression, which is partly cultivated, but surrounded by desert lands above the present limits of irrigation, and in communication with the Fayûm by a narrow neck at R.L. 16·00 (16 metres above mean sea-level).

Adjacent to the Gharaq Basin is another more considerable depression with an area of about one-quarter that of the Fayûm (at contour R.L. 25·00). This depression, known as the Wadi Raiân, had attention drawn to it by Mr. Cope Whitehouse, who proposed its utilisation as a reservoir for controlling the Nile floods, and supplementing the low summer Nile. This Wadi is now bare desert. Its lowest point is 40 metres below sea-level, and the depression thus corresponds, as a geological formation, with the Fayûm depression, the lowest point of which (the bed of Lake Qurûn), is known to be not less than 48, and is perhaps as much as 60 metres below mean sea-level, but soundings are required to establish the actuality of the greater depth.

The Wadi Raiân is surrounded by hills, on all sides rising above the

level of + 36, except at two gaps in the hills separating it from the Gharaq Basin, which have their sills at R.L. 27·00 and 26·00 respectively.

The Fayûm Depression.—The Fayûm Province has the shape of a leaf, (see Plate XIX.) of which the Bahr Yûsuf, from its entrance at Lahûn to its end at Medineh, forms the stalk, and the different canals, branching from Medineh, the veins. The province is generally described as being formed of three plateaux, but this description can only properly be applied to that part of the Fayûm, most rich in Nile deposit, which lies between the main south drain (Wadi Nezlâh) and the main north-east drain (the Bahr Bilamâ or Wadi Tamîyah).

The lower section given on Plate XI, which is typical of this part of the Fayûm, shows the three plateaux, and gives the different surface inclinations. The contoured diagram, Plate XIX., also shows the conformation of the Fayûm Province.

The two strips of land outside the main drainage lines have a different character, and considerably less Nile deposit (see Map).

Medineh, the chief town of the Fayûm, from which most of its canals and roads radiate, stands on ground (R.L. 22·50) three to four metres lower than the land of the Nile Valley in the neighbourhood of Lahûn, where the Bahr Yûsuf turns westward to enter the Fayûm.

From Medineh for 8 kilometres the country surface slope is 1 in 1400, for the next 4 kilometres 1 in 666, and then 1 in 150, till the Birket-el-Qurûn (Lake of the Horns) is reached. This lake occupies the lowest part of the Fayûm, and at the beginning of 1892 its water surface level was 43·30 metres below mean sea; while the bed of the lake is 5 metres lower at least.*

The Fayûm and Wadi Raiân together are everywhere encircled by a continuous range of hills, except where the Bahr Yûsuf enters through the gap in the Libyan Hills, and also towards the north of the Fayûm, where the height of the hills becomes less, but where there is probably no gap lower than R.L. 30, though this has not been actually established by levelling.

The Birket-el-Qurûn and Evaporation.—Such being the physical features

* A maximum of 20 metres is obtained from statements made by the fishermen. Crossing to Dimay, the greatest depth I obtained was 4·85 metres, but the fishermen said that at a point towards the south-west four times that depth was to be found, but I have not yet been able to verify this statement.

of the Fayûm, it is evident that there is no outflow for the drainage of the province. All the drainage (except that of the Gharaq Basin) finds its way into the Birket-el-Qurûn and there evaporates. The present surface area of the lake is not accurately known, but being about 40 kilometres long by 5 broad, the area is about 200 square kilometres (78 square miles).

Notwithstanding the considerable quantity of water that drains into the lake during the twelve months of the year, its level has fallen steadily of late years. The following table gives the measure of the fall from the first of March of one year to the first of March of the next.

LEVEL ON 1st MARCH.						
Year.	Metres below Sea.					Fall.
1885	..	..	39·80	..	..	..
1886	..	..	40·00	..	..	·20
1887	..	..	40·38	..	..	·38
1888	..	..	40·73	..	..	·35
1889	..	..	41·17	..	..	·44
1890	..	..	42·00	..	..	·83
1891	..	..	42·78	..	..	·78
1892	..	..	43·32	..	..	·54
Total fall from 1st March, 1885, to 1st March, 1892 ..						3·52 metres
Yearly average						·50 nearly.

There are no records of the level of the lake previous to 1885. Linant Pasha states in his 'Mémoires' that Vansleb, who was in the Fayûm in 1673, said that one embarked at Sanhûr to pass to the other side of the lake. Dead tamarisk bushes standing in the water seem to prove that the lake has in the past been lower by a metre or more than it is at present, for these tamarisks grow along the margin of the lake above the water edge, but not in it.

The fall of the lake is not continuous throughout the year, but generally takes place from the 1st March to the 31st October; the level rises from the 1st November to the end of January, and remains stationary during February.

If the area of the lake were more accurately determined, there are several problems of interest connected with evaporation and the "duty" of water which might be calculated out from the facts known about the fall of this lake, the level of which is recorded daily. The discharge entering the Fayûm throughout the year is known, as also approximately the areas

under crop; but while the area of the lake remains so vaguely guessed at, the results of the calculation would be of little value, as the figure representing the lake area is an important factor in the calculations.

But the following figures give a measure of what the daily evaporation is in June and July, at least approximately:—

In 1889 and 1890, when there were exceptionally short summer supplies, and the drainage into Lake Qurûn must have been as little as it ever is, the lake levels were as follow:—

Date.	Level of Lake. R.L.	Fall in 30 Days.	Daily Average.
1st June, 1889	— 41·63	..	..
1st July „	— 41·87	·24	·008
31st July „	— 42·11	·24	·008
1st June, 1890	— 42·38	..	..
1st July „	— 42·66	·28	·0093
31st July „	— 42·89	·24	·008

The evaporation, then, could not have been less than ·0093 of a metre per diem in June 1890; or less than ·008 per diem in June and July 1889 and July 1890.

Allowing for a slight amount of drainage finding its way into the lake, an estimate of 1 centimetre a day for evaporation during the three hottest months of the summer would seem to be nearly correct.

We have also the following figures:—

	R.L.
On 14th March, 1890, the lake level was	— 42·00
On 18th September, 1890 „	— 43·13
The fall in 188 days was therefore	1·13
Giving a daily average of	·006

As, for half this period, the flow of water into the lake must have been considerable, the average fall per diem due to evaporation for these six months must have been certainly over 6 millimetres.

Observations on evaporation made in the Abassieh Observatory in Cairo

PLATE I.



THE BAHR YÛSUF, SKIRTING THE LIBYAN DESERT, IN THE NILE VALLEY.

give the following figures as the measure of the average evaporation for each month of the year :—

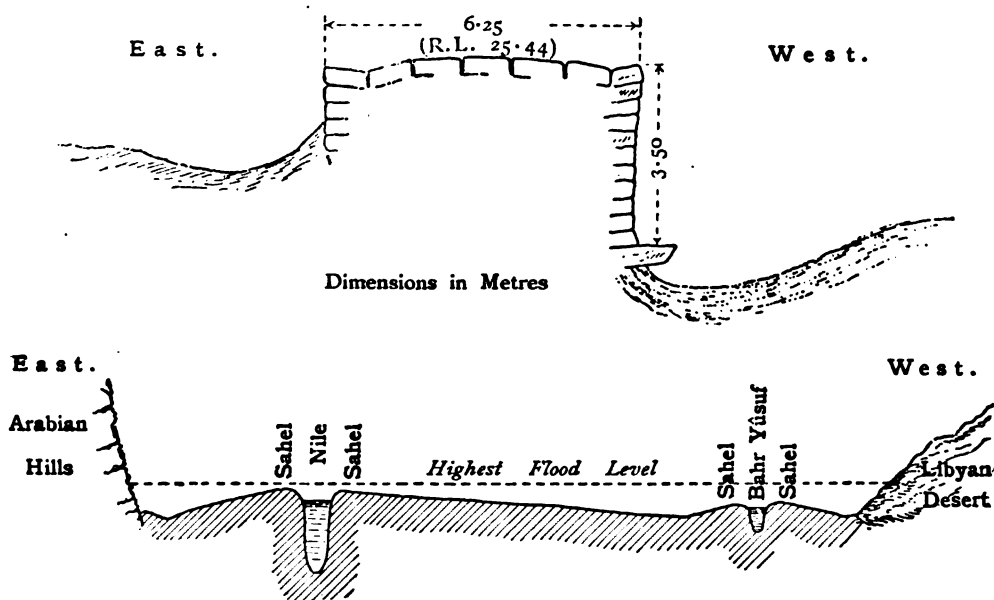
					Metres.	
January	..	..	..	..	·071	
February	..	..	..	..	·074	
March	..	..	..	..	·172	
April	..	..	..	..	·193	
May	..	..	..	..	·252	
June	..	..	..	..	·299	Average per diem for three hottest months, ·0107.
July	..	..	..	..	·370	
August	..	..	..	..	·310	
September	..	..	..	..	·226	
October	..	..	..	..	·179	
November	..	..	..	..	·120	
December	..	..	..	..	·098	
Total	..	..	..	..	2·364	metres per annum.

The average per diem for the three hottest months of the year, according to these observations, is ·0107, as against ·01 deduced from observations of the levels of Lake Qurûn. The figure given for July in the above list is higher than I should have expected, as the evaporation of that month I should estimate to be very slightly in excess of that of June or August; that is, about 1 centimetre a day.

The Bahr Yûsuf outside the Fayûm.—The Bahr Yûsuf (Canal of Joseph) is the watercourse that carries the Fayûm supply. It is not an artificial canal, but a naturally formed sinuous channel, resulting from the Nile flood water draining off the lands and following the line of least resistance along the low-lying part of the Nile Valley on the side of the Libyan Desert. Plate I. shows where the Bahr Yûsuf touches the desert and forms a line of separation between the fertile land of the Nile Valley with its grateful shade of trees and the barren desert sands under a scorching sun.

As is usual in the case of rivers which periodically overflow their banks, the land is highest alongside the Nile, and slopes away from it to the hills on either side. The high margins of the Nile are known in Egypt as the "Sahel." As the Bahr Yûsuf has for a great many years been given an artificial connection with the Nile, and been used as a channel to carry flood water to inundate the lands along its course on both sides, it has imitated the Nile in its action on its borders, and raised a "Sahel" of its own on a smaller scale. The cross-section of the Nile Valley is thus roughly represented in the following diagram.

A former artificial connection of the Bahr Yûsuf with the Nile is plainly visible at Derût, 200 kilometres farther up the Nile Valley than Lahûn, the point at which the Bahr Yûsuf turns westward into the Fayûm. The artificial part is easily distinguished from the natural channel, as the former



is straight with high spoil banks, resulting from the earth excavated to form the channel, whereas the latter is sinuous without any signs of spoil banks. The length of the channel from Derût to Lahûn, measured along its windings, is 270 kilometres, as against 200 kilometres measured as the crow flies.

A second artificial connection with the Nile farther south was made at Manfalût by the excavation of a channel 30 kilometres in length. The part of this that remains now is called the "Manfalûtîyah" or "old Bahr Yûsuf." About twenty years ago a large canal, called the Ibrahimîyah, was made for the irrigation of the Khedive Ismail Pasha's large sugar-cane plantations. It was made to take off from the Nile at Asyût, 30 kilometres above Manfalût and 61 kilometres above Derût. It absorbed part of the Manfalûtîyah Canal from Beni Qora to Derût. At Derût, regulators of a fine description were constructed for the distribution of the water, and a regulator of five openings of three metres' span, with a lock 8.50 metres wide, was made as the head work of the Bahr Yûsuf, which under the new nomenclature became a branch of the Ibrahimîyah Canal. When the Ibrahimîyah Canal was first

PLATE II.



BRIDGE CARRYING THE BAZAAR STREET. MEDINET EL FAYŪM. OVER THE BAHR YŪSUF.

opened, it appears from the *Mémoires on Public Works*, published by Linant de Bellefonds Bey in 1872-73, that its discharge was small compared with its present discharge, and the Fayûm summer irrigation must have been limited. M. Linant states that the bed width of the main Ibrahimîyah was 35 metres, and its reputed depth in summer 1·50 metres; but, in consequence of the inefficient means of dredging, a depth of one metre at most was all that could be obtained at the lowest level of the Nile; and he calculates that the minimum discharge, which theoretically should have reached Derût, was 666,840 cubic metres per 24 hours (273 cubic feet a second), but, in consequence of the inefficient dredging, no more than 369,624 cubic metres per 24 hours (151 cubic feet a second) were delivered. Under present conditions in the worst years the minimum has never fallen below two million cubic metres per 24 hours (818 cubic feet a second) since, at any rate, 1883.

Of the Bahr Yûsuf before the Ibrahimîyah Canal was made, M. Linant remarks in the same *Mémoires*, that "it is the only canal in Egypt which, without receiving water from the river during the summer, nevertheless has enough to serve for the irrigation of the Fayûm from the springs in its bed." These springs still supplement the summer supply of the Fayûm by adding to the discharge, which is apportioned to the Bahr Yûsuf at Derût, about a quarter of a million cubic metres a day (102 cubic feet a second).

During the summer and winter the water of the Bahr Yûsuf is (with the exception of an insignificant quantity lifted for the irrigation of small areas at different points along its course) reserved for the Fayûm, but during the flood season its channel is used to carry water for the inundation of the lands on both sides of it, and later it is made use of as the channel of discharge for the basins which it has filled, or helped to fill.

At Lahûn, where the Bahr Yûsuf turns into the Fayûm, the quantity of water admitted is controlled by two regulators. The lower bridge is a very ancient one (frontispiece), of what date is unknown. Its floor in Linant Pasha's time had already partly given way, but from his description it would seem to be now in the same state in which it was more than twenty years ago. The upstream half has evidently been added to the downstream half, as there is a clean line of separation in the middle of the length of the present archway. This is only to be seen by entering the passage below the arches, as the junction is not visible from above.

In 1838 Linant Pasha caused the second regulator of three openings (two of three metres' and one of four metres' span) to be constructed as a

precaution 80 metres above the old one, and it was a very wise precaution to take. The head of water is now divided between the two bridges so that the action is less severe than it was before the second bridge was constructed.

The present discharges passed by these regulators into the Fayûm are :—

During the flood season $6\frac{1}{2}$ to 7 million cubic metres per day (2658 to 2863 cubic feet per second).

During the winter season 3 million cubic metres per day (1227 cubic feet per second).

During the summer season $1\frac{1}{2}$ to 1 million cubic metres per day (713 to 409 cubic feet per second).

The ordinary and maximum and minimum levels of the Bahr Yûsuf are given in the list below :—

		Below Derût.	Above New Bridge, Lahûn.	Below Old Bridge on Fayûm Side.
Flood season		46·75	26·50	23·90
Winter		43·00	24·14	23·15
Summer		42·15	22·90	22·50
Maximum		46·95	27·80	23·90
Minimum		41·67	22·50	22·27

The Bahr Yûsuf inside the Fayûm.—At the end of the Bahr Yûsuf at Medineh the water-level is now kept constantly at R.L. 21·70 to 21·80. In Nile time any increase on this tail level is forbidden by the effect of the heading-up caused by the obstructions met with by the large flood discharge in its passage through the town between the houses which line its edges. The Bahr Yûsuf is bridged in this length twice, first by a three-arched bridge, Plate II., which carries the main street and bazaar of Medineh; and again by a two-tubed tunnel, over which the mosque of Kait Bey is built, Plate III.

In passing through the bazaar with shops on either side the Bahr Yûsuf is crossed without its being noticed, and a stranger to the town is presently surprised to find himself on the other side of the canal to which he imagined himself to be.

PLATE III.



TUNNEL ON BAHR YŪSUF.
OVER WHICH THE KAIT BEY MOSQUE IN MEDINET EL FAYŪM IS BUILT.

The waterways of these two constructions are sufficient to pass the winter discharge with but slight heading-up, but when the flood supply is flowing, they (assisted perhaps by old blocks of masonry and débris of fallen houses in the channel) cause a backing-up of the water of from 50 to 60 centimetres and thereby (with the level at the tail below the town fixed at R.L. 21·80) produce the maximum level above the town, which it is safe to allow.

The distance from Lahûn to the end of the Bahr Yûsuf at Medineh along the canal is 24 kilometres (15 miles). Between kilometre 11 and 14 the bed is rock, the highest point of the bed being at R.L. 21·00 and between kilometre 12 and 13. The bed elsewhere is generally between R.L. 17 and 19.

At kilometre 10·130, the Bahr (canal) Sêlah takes off on the right, and after flowing by the Hawârah pyramid and passing under the Fayûm railway, its water surface comes level with the soil and irrigates the strip of land bordering the Fayûm depression on the right of the main drainage line on this side.

Similarly at kilometre 15·5 the Bahr Gharaq takes off on the left of the Bahr Yûsuf, and, aided by the Bahr Qalamshah, irrigates the east slope of the Fayûm and the whole of the Gharaq Basin. The strip on the left of the south main drainage line, forming the sloping side of the Fayûm Basin on the south, is irrigated by the Bahr Nezlâh, which takes off from the main canal at kilometre 16·370.

With the exception of the Bahr Tamîyah, which flows in the channel of the north-east main drain itself and irrigates the distant north corner of the province on the right of the drain, all the other canals irrigate the central part of the Fayûm, which lies between the two main drainage lines. These canals may be divided into three classes corresponding to the three plateaux :—

1. The short and high level canals irrigating the high land on both sides of the Bahr Yûsuf and round Medineh, roughly speaking all lands down to contour R.L. 18·00.

2. The medium canals, which irrigate between R.L. 18·00 and 10·00, or thereabouts.

3. The long ravine canals, which carry water to the distant parts of the Fayûm below contour R.L. 10·00.

In a lawless province like the Fayûm, such an arrangement of canals is of great assistance in the equal distribution of water to all parts of the province. The long canals of class 3 are, in their upper reaches, so far

below the cultivated surface of the soil, that no crop-owner of the first and second plateaux would attempt to irrigate from them except by means of water-wheels, which have to be regularly licensed. The canals of the 2nd class are intermediate in level and length between the first and third, and do not conveniently irrigate, except at some considerable distance from their heads.

There is a further advantage gained by the water of the long canals falling at once to low levels at their commencement. Along the margins of the Bahr Yûsuf and round about Medineh is a considerable area of valuable land above the highest level reached by the water in the parent canal. To irrigate this, water is lifted in pitchers fastened to the side of the outer edge of undershot wheels, which are turned by the force of the water descending to the low-level beds of the ravine canals. These wheels turn day and night without ceasing, so long as there is sufficient water. A head of 25 centimetres is sufficient to turn an ordinary wheel which lifts the water about 2 metres, but when greater heads are obtainable, water is lifted in this way as much as from 4 to 6 metres (Plate IV.) A fall of 80 centimetres will work two wheels, one behind the other, which lift the water 5 metres.

The channel, carried by the imposing looking aqueduct of Plate IV., is only 40 centimetres wide by 30 centimetres high, the whole thickness of the aqueduct being only 85 centimetres. The expense, incurred in building it, points to the value of a constant stream of water raised in this manner.

There are two kinds of wheels used, one in which the water lifted is contained in earthenware jars fastened to the side of the wheel near its outer edge, the arrangement of which is shown by the drawing, reproduced from Willcocks' 'Egyptian Irrigation' (Plate V.) The other kind of wheel, called a *tabût*, has a hollow chambered tube of square cross-section forming its circumference, the holes to admit water into each chamber being made in such a position that the water, which enters the chamber when submerged, does not commence to flow out again, till the chamber approaches the highest point of its path. Below the point, at which the flow out commences, a trough is placed to catch the water.

It will be seen that in both these arrangements there is a loss of work in lifting the greater part of the water rather higher than the level at which it is utilised. The principle of the *tabût* will be understood from the drawing given on the same plate No. V., as the other arrangement with pitchers. Either kind is known as a *saqya hedér*.



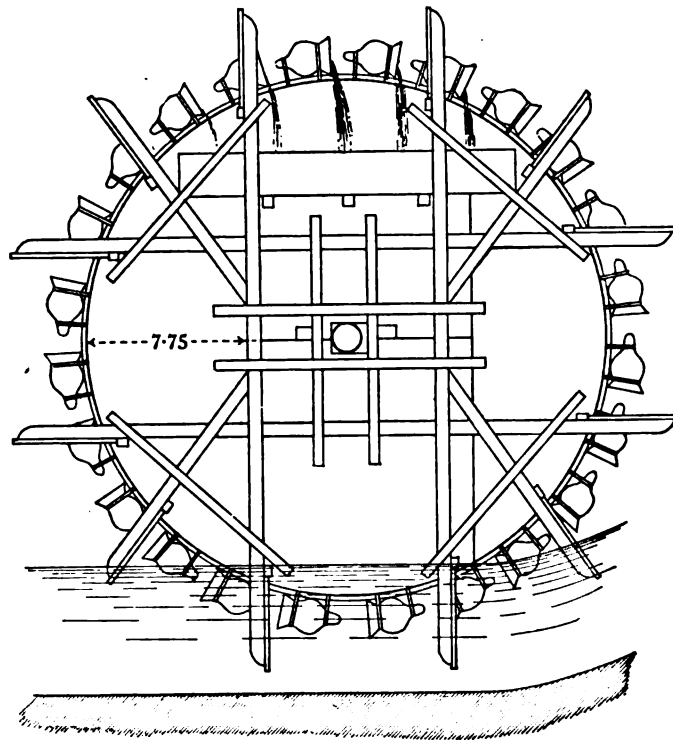
HIGH-LIFT WATER-WHEELS ON THE TAMĪYAH CANAL.

The pair of wheels shown on this Plate raise the water 4·50 metres, and are worked by a total fall of water of 0·55 metres.

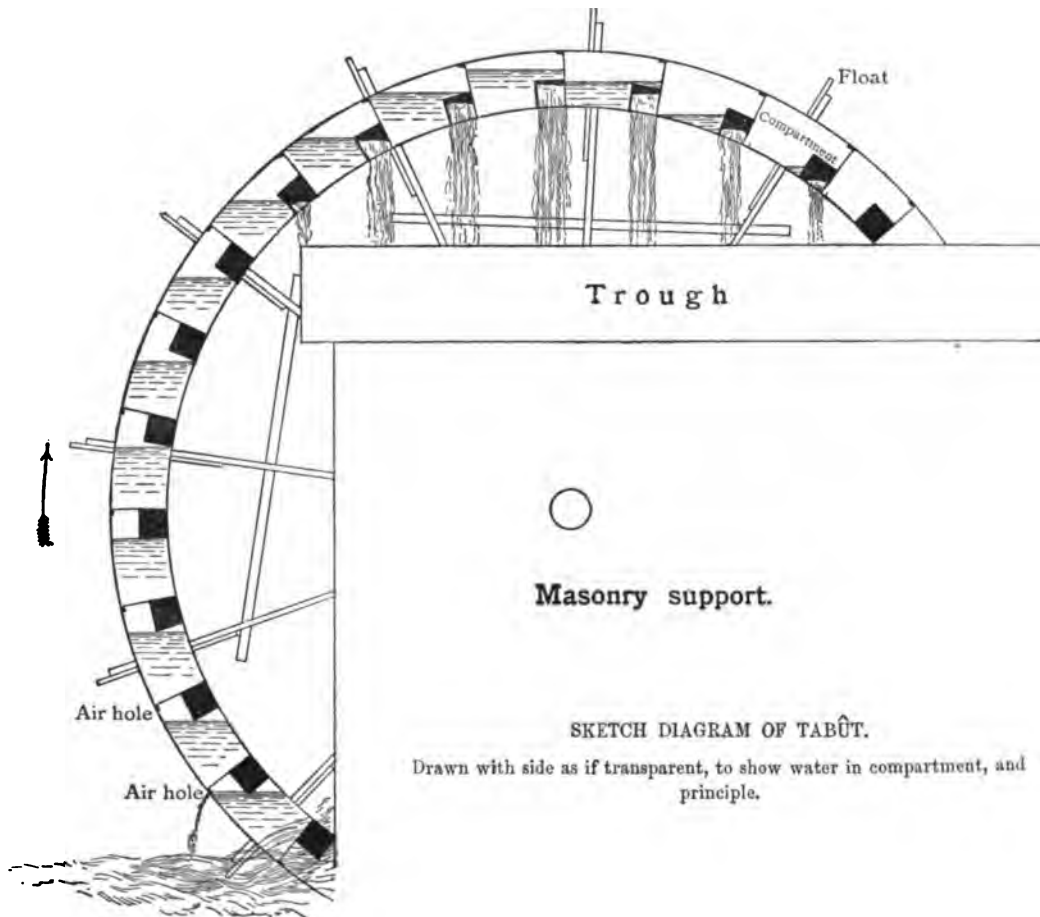
As a means of estimating the heights and widths in the Plate, the widths of the arches are given.

Left-hand arch, 3 metres span; next arch on its right, 2½ metres span.

PLATE V.



UNDERSHOT WHEEL FOR RAISING WATER.
Scale $\frac{1}{8}$ ". From Willcocks' 'Egyptian Irrigation.'



The *saqya mawâshi* (saqya worked by cattle) and the *shadûf* are also employed to a small extent, as elsewhere in Egypt, but only for small areas.

There are 205 saqya hedêrs in the province. To obtain a license to erect one, the applicant has to pay L.E. 1 to get his application accepted, and L.E. 5 more, if the license is granted.

Water-mills.—The fall of the water is also used to turn mills for grinding corn, of which there are 243 in the province, which paid as tax in 1891 a total of 810*l.* (L.E. 791).

Plate VI. is from a photograph of one of the falls, below which are first a pair of tabût wheels, one behind the other, for lifting water to high-level lands, and, below these in the same mill-race, an undershot wheel working a mill for grinding corn.

The mills are worked either by turbines (*panchakkis*) of a pattern introduced from India thirty years ago, according to Mr. Willcocks, or by undershot wheels. The latter method is used, where the fall available to work the mill is small, but not less than 60 centimetres. The former system requires a fall of at least 1·60 metres.

Falls and Regulators.—For purposes of irrigation the fall of the country surface is excessive, and works have to be built at intervals along a canal, after the point where it begins to irrigate, to hold up the water-surface to a sufficient height to flow over the fields. These works are generally placed where the canal splits up into branches, and they take the form of a collection of small weirs. Where the maximum water-levels below all the weirs of such a group never rise above the level of their weir-sills we have a “free fall” in the case of each weir, and the discharge over each sill is directly proportional at all seasons to the length of the sill, which in each weir is made proportional to the area irrigated from the canal below the weir. Thus the collection of weirs not only holds up the water for the irrigation from the canal above it, but acts automatically as a just distributor of water to the canals below it. Such a group of weirs is called a *nasbah*, an Arabic word signifying “proportion.” The arrangement is thoroughly understood and appreciated by the Fayûm cultivators, and is useful in rendering unnecessary the employment of a numerous establishment of low-paid agents—a great end to gain in a country where the inferior employés are so easily corrupted.

There are, besides the nasbahs, a large number of small masonry works, as head regulators, sluice heads to branch canals, syphons, aqueducts,

PLATE VI.



NASBAH MITERTARIS.

and pipe heads scattered all over the province, but there is nothing peculiar in them as irrigation works.

The upper bridge at Lahûn has hitherto been closed by vertical needles, but in 1892 it has been altered, and will in future be regulated by horizontal planks. The openings have also all been made one width, namely, 3 metres.

Crops.—The area on which land tax was paid in 1891 was

Ushuri lands	131,155 feddans.
Kharagi „ .. .	102,146 „
Total ..	233,301 „

The total amount received into the Government treasury on this area was L.E. 132,668, which gives an average of 57 piastres a feddan, or 11s. 2 $\frac{3}{4}$ d. an acre.

The actually cultivated area of the Fayûm is said to be about 280,000 feddans. Almost the whole of this area is under crop during the flood season and winter, and about 50,000 to 60,000 feddans are planted with summer crops, chiefly cotton.

If cotton is grown, it is followed by a winter crop of wheat, clover, or beans, and this is followed by a flood crop of millet. The cotton is sown in March of one year, and the flood millet is harvested in November of the following year, so that three crops are obtained in twenty months. After the flood millet, clover will be sown, and this will be cleared off the ground in time to plant cotton, which will be picked and finished with in October. This makes five crops in thirty-one months. I believe that sometimes even this record is beaten, and three crops are got out of fifteen months.

Everything which is sent out of the Fayûm, with the exception of an insignificant quantity which is carried out by camels, is shown in the railway books, from which the following figures, in kantars, have been obtained. (A kantar = 98·09 lbs.)

EXPORTS FROM THE FAYÛM PROVINCE.

	1889.	1890.	1891.
Cotton	39,433	56,334	86,638
Cotton-seed ..	82,010	104,608	125,917
Cereals	418,935	797,363	1,109,070

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The value of the exports in 1891 was not less than that given in the following calculation :—

	Kantars.		Piastres.		L.E.
Cotton	86,638	at	170	=	147,284
Cotton-seed	185,917	at	55	=	102,254
Cereals	1,109,070	at	70	=	776,349
Total					= 1,025,887

The area on which an average land tax of 57 piastres a feddan was paid has been given before as 233,301 feddans (242,166 acres). Hence the value of cotton, cotton-seed, and cereals exported from the Fayûm in 1891 was at the rate of L.E. 4·397 a feddan (4*l.* 6*s.* 10*d.* an acre).

Clover, which is extensively cultivated, is all consumed in the province.

Besides the above, the Fayûm exports also figs, grapes, olives, quail, fish, mats, baskets, and a few other things.

The province is justly famed for its excellent figs, but the grapes are not of superior quality to those of other parts of Egypt, though they have the reputation of being so.

In 1891 Government farmed out the fisheries for a sum of L.E. 2000. Every day large numbers of fish, chiefly *bulti* (Nile carp) are sent in crates to Cairo. The *bulti* is excellent eating. Another common fish is the *armûd*, or Nile shad-fish *alias* sheath-fish or cat-fish (*Silurus*). It is considered by the natives to be good to eat, but according to others it is not fit for food.

Another handsome fish, called by the fishermen *lâl*, and also a fine species of the perch family, known to them as *lafâsh*, both from their appearance good table fish, are not uncommon, except by comparison with the abundant carp. The *lafâsh* grows to a great size, one that I photographed, measured, and weighed being 1·32 metres long, of 1 metre girth, and 92 lbs. weight.

The fishermen move about the lake in the most primitive kind of boats, propelled by the clumsiest possible oars, and without any sails. How long they will continue to be satisfied with their craft it is hard to say, but they show no signs of desiring anything better.

CHAPTER II.

ANCIENT TESTIMONY ABOUT LAKE MÖERIS.

EVIDENCE concerning the existence of Lake Möeris, which has been briefly referred to in the Introduction, is to be gained from the following sources :—

The Egyptian monuments, in which are found inscriptions on stone and records on papyri.

The writings of Herodotus, who visited Egypt B.C. 450.

The writings of Diodorus Siculus, a Sicilian, and of Strabo, a Greek geographer and contemporary with Diodorus, about B.C. 25.

Lastly Pliny, A.D. 50 to 70.

It must be borne in mind, while reading their accounts, that, in attempting to give information as to the origin of Lake Möeris, they were undertaking a task beyond their powers, since, according to the scanty revelations of the monuments, which on this point are the only witnesses worthy of credence, the Lake Möeris *existed* 2000 years before Herodotus visited Egypt, and therefore must have been *formed* at a more remote date. What then these ancients may have been told as to the *origin* of Lake Möeris may well be classed with tradition, and be assigned its true value as such, but what they state, that they themselves *saw*, is as worthy of belief as statements found in the descriptions of any other sober historian's personal experiences.

I am indebted to the Rev. Edwin Meyrick, M.A., for the translations of the passages from Herodotus, and to Mr. Edward Meyrick, of Marlborough College, for those from the other classics.

*Translations from Ancient Authors, who have referred to Lake Möeris,
and Arabic Tradition.*

HERODOTUS, Book II. (B.C. 454).

“These twelve kings (who were governing Egypt at the time of which Herodotus was writing) agreed to leave a work which should make their

names remembered, and, uniting all their powers, they built the Labyrinth, a little above the Lake Mœris, and situated as nearly as possible opposite the city called Crocodilopolis. (Here follows a description of the Labyrinth, in which it is stated to surpass the pyramids as a wonder of construction.)

“Adjoining the angle where the Labyrinth ends, is a pyramid, 240 feet high, on which large figures of animals are engraved. The entrance into this is subterranean.

“Now, the Labyrinth being such as I have described, the lake, named that of Mœris, causes still greater astonishment, on the bank of which this Labyrinth was built. The perimeter of this lake measures 3600 stadii, which is the same thing as 60 schoeni. This measure is nearly equal to the entire seaboard of the whole of Egypt.

“This lake lies oblong north and south, being in its deepest part 50 fathoms deep. It tells its own story that it is artificially made, for about the middle of the lake stand two pyramids, out-topping the water 50 fathoms each, and that part of them which is built under water is as much more. On the top of each is a colossal figure in stone, seated on a throne. So these pyramids are 100 fathoms high. Now, 100 fathoms are exactly equal to a stadius, consisting of six plethra, seeing that the fathom is equal to 6 feet, or four cubits, a foot measuring four palms, a cubit six palms.

“The water in the lake is not derived from local sources, for the earth in that part is naturally excessively dry and waterless, but it is brought in from the Nile by a canal. It takes six months filling and six months flowing back. During the six months of the return flow, it yields a talent of silver each day to the Treasury, and during the flow in, twenty minæ from the fish.

“The people of the country also told me that this lake on its western face, inland along the mountain which is over Memphis, has an underground outlet into the Syrtis, which is in Libya. But when I nowhere saw the earth-mounds which came from this excavation (for this was much upon my mind) I questioned those who lived in the neighbourhood of the lake as to where the excavated material could be. They told me that it had been carried out, and without difficulty they led me to believe it. For I knew by report that a similar thing had taken place in Nineveh, the city of the Assyrians. For burglars contrived a plan to carry off the treasures of King Sardanapalus, son of Ninus, which were valuable and guarded in subterranean treasuries. These burglars then, starting from their own dwellings, and calculating the distance, tunnelled to the palace. And when night came

on they carried out the material, which was removed from the excavation into the river Tigris, which flows past Nineveh, until they accomplished what they wished. In a similar way to this I heard that the excavation also of the lake in Egypt had been carried out (except that it was done by daylight, not by night), inasmuch as the excavators carried the material to the Nile, and the Nile, receiving it, would disperse it. In this way the lake is said to have been excavated."

STRABO, Book XVII. (B.C. 24).

Writing of the Arsinoïte Nome he says, "This province is the most remarkable of all in appearance, natural properties, and embellishment. It grows olive-trees which bear fruit. It produces wine in abundance, corn, pulse, and a great variety of other grains. . . .

"It has also a remarkable lake called the Lake of Moëris, large enough to be called a sea, and resembling the open sea in colour; its shores are also similar in appearance to sea-beaches, whence we may suspect a community of nature between them and the district about Ammon. For they are in fact not far distant from one another or from Parætonium, and as there is good reason to suppose that the latter temple formerly stood on the sea-shore, so also this district must formerly have been littoral. Lower Egypt and the parts towards the Serbonian Lake were then covered by the sea, perhaps connected with the Red Sea by Heroöpolis and the Elanitic Gulf. . . .

"Thus, the Lake of Moëris is, from its size and depth, capable of receiving the overflow of the Nile at its rising, and preventing the flooding of houses and gardens; when the river falls, the lake again discharges the water by a canal at both orifices, and it is available for irrigation. There are regulators at both ends of the canal for controlling the inflow and outflow. Near these is an immense stone Labyrinth, a work comparable with the Pyramids; and the tomb of the king who constructed it. . . .

"Sailing 100 furlongs further one comes to the city Arsinoë, formerly called Crocodilopolis."

DIODORUS SICULUS, Book I. Chap. LI. (about B.C. 20).

"He (King Moëris) dug a lake 600 furlongs above the city (Memphis), which is amazingly useful and incredibly large. Its circumference is said

to be 3600 furlongs, and its depth in most parts 50 fathoms. . . . For as the rising of the Nile is irregular, and the fertility of the country depends on its uniformity, he dug the lake for the reception of the superfluous water. And he constructed a canal from the river to the lake 80 furlongs in length and 300 feet in breadth. Through this he admitted or let out water as required, the mouth being opened or closed by an elaborate and costly process (for it cost not less than 50 talents whenever any one wished to open or close the mechanism). This lake has continued to serve the Egyptians for this purpose down to our own times, and is called the Lake of Mœris after its constructor. When the king dug it he left in the centre a place on which he built a tomb and two pyramids, one for himself and the other for his wife, a furlong in height, expecting thus to leave an immortal reputation for his benefactions. The revenue of the fisheries in the lake he gave to his wife for her allowance for perfumes and cosmetics generally; they brought in a sum of a talent of silver daily; for there are said to be twenty-two kinds of fish in it, and the quantity taken is so large that the numerous hands engaged in the salt-curing industry can hardly keep pace with the work."

PLINY, Nat. Hist., Book V. Chap. 9 (A.D. 50-70).

"Between the nomes of Arsinoë and Memphis was a lake, 250 miles (i.e. Roman miles) in circumference; or, as Mucianus tells us, 450 miles in circumference and 50 paces in depth, artificially constructed, called the Lake of Mœris, from the king who made it. Seventy-two miles distant from this is Memphis, formerly the capital of Egypt."

PLINY, Nat. Hist., Book XXXVI. Chap. 16.

"There were two other pyramids near the Lake of Mœris, which is a large excavation."

ARABIC TRADITION,

as given by Mr. Cope Whitehouse in his article entitled "The Expansion of Egypt" in the *Contemporary Review*, September 1887, translated from an Arabic manuscript which once belonged to Cardinal Mazarin:—

"Joseph, to whom may Allah show mercy and grant peace, when he was Prime Minister of Egypt and high in favour with Raiyan, his

sovereign, after that he was more than a hundred years old, became an object of envy to the favourites of the king and the puissant seigneurs of the Court of Memphis, on account of the great power which he wielded and the affection entertained for him by his monarch. They accordingly thus addressed the king: 'Great king, Joseph is now very old; his knowledge has diminished; his beauty has faded; his judgment is unsound; his sagacity has failed.' The king said: 'Set him a task which shall serve as a test.' At that time el-Fayoum was called el-Hun, or the Marsh. It served as a waste basin for the waters of Upper Egypt, which flowed in and out unrestrained. The courtiers having taken counsel together what to propose to the king, gave this reply to Pharaoh: 'Lay the royal commands upon Joseph that he shall divert the water of the Nile from el-Hun and drain it, so as to give you a new province and an additional source of revenue.' The king assented, and summoning Joseph to his presence, said: 'You know how dearly I love my daughter, and you see that the time has arrived in which I ought to carve out an estate for her out of the crown lands, and give her a separate establishment, of which she would be the mistress. I have, however, no territory available for this purpose except the submerged land of el-Hun. It is in many respects favourably situated. It is a convenient distance from my capital. It is surrounded by desert. My daughter will thus be independent and protected.' 'Quite true, great king,' responded Joseph, 'when would you wish it done? for accomplished it shall be by the aid of Allah, the all-powerful.' 'The sooner, the better,' said the king. Then Allah inspired Joseph with a plan. He directed him to make three canals; one from Upper Egypt, a canal on the east, and a canal on the west. Joseph collected workmen and dug the canal of Menhi from Ashmunîn to el-Lahûn. Then he excavated the canal of el-Fayoum, and the eastern canal, with another canal near it called Ben-Hamed to the west. In this way the water was drained from el-Hun; then he set an army of labourers at work. They cut down the tamarisks and bushes which grew there and carried them away. At the season when the Nile begins to rise the marsh had been converted into good cultivable land. The Nile rose; the water entered the mouth of the Menhi canal and flowed down the Nile Valley to el-Lahûn; thence it turned towards el-Fayoum, and entered that canal in such volume that it filled it, and converted the land into a region irrigated by the Nile. King Raiyan thereupon came to see his new province with the courtiers who had advised

him to set Joseph this task. When they saw the result they greatly marvelled at the skill and inventive genius of Joseph, and exclaimed : ' We do not know which most to admire, the draining of the marsh and the destruction of the noxious plants, or the conversion of its surface into fertile and well-watered fields.' Then the King said to Joseph, ' How long did it take you to bring this district into the excellent state in which I find it ? ' ' Seventy days,' responded Joseph. Then Pharaoh turned to his courtiers and said : ' Apparently one could not have done it in a thousand days.' Thus the name was changed from el-Hun, or the Marsh, to el-Fayoum, ' the land of a thousand days.' "

This pun is not to be appreciated in the translation without a knowledge of Arabic. *Elf* is the Arabic for a thousand, and *yôm* for a day ; *elf-yôm* being a thousand days. As the work took seventy days to complete, according to the tradition, it does not appear clear why it should have been called " the land of a thousand days " instead of " the land of seventy days." But the tradition must not be criticised, as it will not stand it.

The name Fayûm is derived from an old Coptic word *phiûm* signifying a sea or lake ; *el* is simply the definite article.

CHAPTER III.

THEORIES AS TO WHERE AND WHAT LAKE MÖERIS WAS.

Postulates.—There seems to be a general agreement that Lake Möeris was in the Fayûm, the evidence being conclusive. There is, further, no disposition shown to question the fact, that the Labyrinth and the pyramid alongside it, were on the borders of Lake Möeris, and that the present capital of the Fayûm, Medineh or Medinet-el-Fayûm, occupies part of the site of the ancient town of Crocodilopolis, or, as it was called afterwards, Arsinoë.

There seems also to be sufficient evidence for accepting the conclusion, that the site of the Labyrinth was at the foot of the Hawârah pyramid.

It also seems to be agreed to accept the testimony of Herodotus, Strabo, and Diodorus, when they describe the uses which Lake Möeris served, namely, to receive part of the Nile waters when the river was in flood, and so to moderate its excesses, and also to return the stored-up water to the Nile, when its discharge had fallen low in summer, and so to supplement its deficiencies.

Statements not accepted as postulates.—These same witnesses made other statements, which have been accepted or rejected according to the individual views of different theorists. If Herodotus and others after him are rightly interpreted as stating that the Lake Möeris was artificially dug out by human labour, I too must claim the privilege of assuming that they were mistaken. As pointed out at the commencement of Chapter II. of this paper, Herodotus was trying to give an account of what took place more than, at least, 2000 years before, with no records to help him. Under such circumstances, accuracy as to the origin of Lake Möeris was not to be expected in his accounts. Being no engineer, and having a large belief in the marvellous, he might well have supposed the whole oasis artificially dug out. The absence of all signs of the earth resulting from this immense excavation puzzled him, and he asked what had become of it.

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He was told that it had been carried to the Nile, whose waters dispersed it, and this he *readily believed*, because he had heard of a similar proceeding in another country, where some thieves excavated an underground passage to a king's treasury, and got rid of the earth resulting from the excavation by throwing it into a river at the outer end of their shaft. This is comparing small and great with a vengeance. The distance of the centre of the Lake Mœris excavation to the Nile would have been 50 kilometres (31 miles), and the quantity of earth to be carried and dispersed by the Nile would have been at least 50,000 million cubic metres. Such a task can scarcely be called similar to a simple mining operation.

The Egyptian of to-day, if asked to account for any assumed fact, will not pause to consider whether the assumed fact is really fact, but will at once invent some more or less plausible explanation to account for it. I will give a remarkable instance of a very generally believed explanation of an annual Egyptian phenomenon, though it has nothing to do with the Fayûm or Lake Mœris. In the summer, the land surface of the inundation basins of Upper Egypt is split up into mazes of deep cracks, into which innumerable rats are seen to disappear when disturbed. On the waters entering the basins all this cracked area becomes submerged, and the question is, what becomes of the rats? Again, when the water is discharged from the basins after remaining in them two months, the rats are found (or appear) to be in as great numbers as before. Again the question is, where have the rats come from? The accepted explanation is that when the water comes the rats turn into mud, and when it retires the mud changes back again into rats. I could scarcely credit that so childish a belief was general, so I submitted the question to a large Assembly of Notables (collected for a different purpose), and several members came forward and declared they had seen the rats in the state of semi-transition, when half mud and half rat, and offered to catch and deliver one to me. I accepted the offer, but the matter has not yet gone any further.

Returning to the discussion of the statement that Lake Mœris was artificially excavated, it strikes one as being a senseless operation to dig out a basin to the depth given as being that of the deepest part of Lake Mœris, viz. 92 metres, as all the water lying below half the depth stated could have served no useful purpose, except from the point of view of aquatic animals that have a liking for deep water.

Theorists lay stress on some features testified to by the ancients, and

explain away or discredit other points of their testimony according as they support or are hostile to their adopted theories; or else they give strained interpretations to other statements from the same motives. Such statements, for instance, as the following are subject to this varied treatment.

Herodotus, and others after him, state that the circumference of Lake Moeris was 720 kilometres (450 miles), or, as some interpret, 360 kilometres, according to the value of the stadius adopted. Depth, 92 metres.

The length of the lake lies north and south. It was artificially made. There were two pyramids, crowned by colossal statues, centrally situated in the lake, as viewed from the Labyrinth or Arsinoë.

The water in the lake was not derived from local sources, but was brought in from the Nile by a canal. The lake was between the Arsinoïte and Memphite nomes.

Crocodilopolis was on or near the borders of the lake, and 9400 metres from the Labyrinth.

Lake Moeris formed an elbow to the west, was oblong, and situate in the middle of the lands along the mountains above Memphis.

These statements are not in the original language in which they were made, and may be inaccurately translated, where accurate rendering is important. I have found for instance in different publications the two following translations of the same passage in Diodorus:—

(a) "A little south of Memphis a canal was cut for a lake, brought down in length from the city 40 miles."

(b) "And a little above the city he cut a dyke for a pond, bringing it down in length from the city 320 furlongs." (Translation by G. Booth.)

A canal and dyke are not synonymous terms, in all parts of England at any rate; nor are lake and pond.

Some of the statements are founded also on hearsay when they were first made, and the ancestors of the present inhabitants of the Fayûm may, for all that is known, have had as great a tendency to the widest possible departure from scientific accuracy of statement in their verbal representation of facts, as it is notorious that their modern successors have. Hence it is not surprising that human nature, which has a parental prejudice in favour of any theory to which it may have given birth, should take advantage of these weak points to the benefit of its offspring.

We will then proceed to discuss the present generation of theories, which exemplify this principle.

LINANT THEORY.

The most important of these theories is that of Linant de Bellefonds Pasha, once Minister of Public Works in Egypt.

His views will be found in Chapter II. of his '*Mémoires sur les Principaux Travaux d'utilité publique exécutés en Egypte depuis la plus haute antiquité jusqu'à nos jours, 1872-1873.*'

His theory, which defines the form and limits of Lake Moëris, appears to have been generally accepted after being propounded, and still to be the accepted theory with many, who have not, by a personal acquaintance with the Fayûm and its actual conformation and levels, corrected the ideas which they had accepted on the authority of Linant Pasha.

(For the names of places quoted from M. Linant's writings I have adopted the more modern way of spelling, as otherwise the places might not be recognised. For instance, had it not been for the context, I should not have been able to recognise the village known as Abûksah in "Bogça.")

Linant's Theory stated.—M. Linant maintains that Lake Moëris occupied the gap in the hills by which the Bahr Yûsuf enters the Fayûm, and covered the so-called "plateau" on the south-east of Medineh, the encircling bank commencing at its north-east end at Edwah, and being continued through el-Alam, Biahmu, Zowyet-el-Karatsah, to Medineh. See Plate VII.

The remains of this bank he traced throughout this length, and saw evidences of it again to the S.S.E. of Medineh.

Thence he *supposed* that it must have passed on to Abgig ("je suppose qu'elle a dû passer à Ebgig"), el Sawafnah, Atamnâh, and Gaafrâh. Then he found it again constructed in masonry over a great length not far from the village of Miniet-el-Hêt. It continues afterwards (according to Linant Pasha) up to Shêkh Abu Nûr, and then takes the direction of "el Gharak in the plain," where it is no longer well defined ("où elle n'est plus bien marquée"). He notes that at Bahr Nezlâh its height (that is, the wall's,) is 12 metres.* He then makes the bank pass on from the south-east of Sélé (?) to between Shêkh Danial and Tutûn, in an easterly direction, and turn to the north by Kalamshah, El Nedlé (?), to the Bahr Yûsuf, then following the Bahr Yûsuf up to Dimishkîn, turning along the banks at Lahûn (Bahlawân and Gedallah), it again returns to the west near Hawârat-el-Maqta, and, following

* Its actual height is under 6 metres as a maximum.

the old canal Wardan, passes the Hawârah pyramid at the village of Dimu and joins the commencement of the bank at the south-east of Sêlah (Sélé).



MAP SHOWING LINANT'S SUPPOSED LAKE MÉRIS.
From Rawlinson's 'Egypt,' 1881.

All the land enclosed by this bank represents the site of Lake Moëris according to the theory of Linant de Bellefonds Pasha.

I give here a map, Plate VII., copied from one of Mr. Cope Whitehouse's papers on the Wadi Raiân, being a reproduction from the 'Egypt' of Canon Rawlinson, as it is a convenient one for demonstrating what this theory is. Linant's Lake Mœris is shown on this map as a dark patch occupying what M. Linant calls the high plateau. The part where "LAKE" is printed is actually the highest part of the Fayûm, at R.L. 22 to 25, if we except the narrow pass by which the Bahr Yûsuf flows in. This latter has its land surface at from R.L. 24 to 26. But the word "MÆRIS" on the shaded area lies over a depression whose bed is at R.L. 12·00, that is, 11 to 12 metres lower than the land surface covered by the word "LAKE" on the same shaded area.

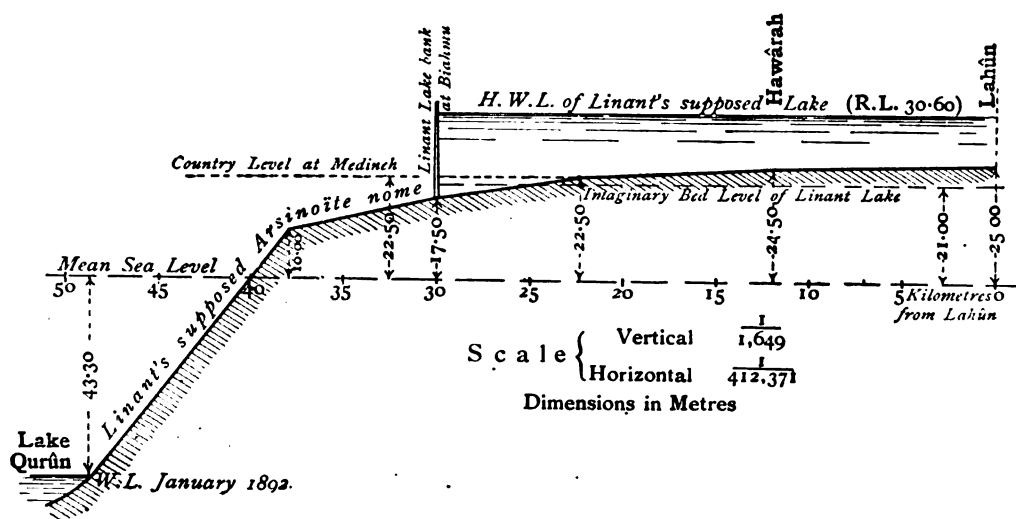
The north boundary of this area through el Edwah and el Alam runs generally along contour R.L. 17·50, 5 to 7 metres below the high plateau. It is therefore incorrect to speak of the ground represented by the shaded area as a plateau.

M. Linant's depth of water in his supposed lake was fixed at 9·60 metres. Its bed must have been at R.L. 21·00, the level of the rock-bed at Hawârah, and its maximum water surface at R.L. 30·60. The height of the surrounding bank would have had to be, on the Edwah-el-Alam line, 15 metres, and at the Wadi Nezlâh (at the initial letter of "MÆRIS" on the map) 20 metres.

Now the country lying between the Linant Lake Mœris and the Birket-el-Qurûn was said to be irrigated from this lake. Imagine the state of insecurity for this tract of sloping land, with a huge reservoir of water standing 13 metres above that part which lies along the north face of the lake, and more than this above the part along the west face. When one considers, too, that there must have been passages for irrigation through this bank, and how dangerous such an arrangement would be, it is scarcely credible that the collection of thriving towns included in the Arsinoïte nome would have grown in such a perilous situation. Imagine, also, the infiltration that would result on the lands along the faces of this lake. According to the theory, the Lake Linant, not being of sufficient dimensions itself to regulate the Nile, was to pass on the surplus into Birket-el-Qurûn by escapes on the two main drainage lines. Thus the poor fools, who had settled themselves on the strip between the two lakes, would be in danger of inundation, both from above and below, and would be in as bad a plight as Pharaoh's horsemen in the Red Sea.

A diagrammatic section of the Fayûm (Plate VIII.), as it would have been when in this unhappy state (fortunately imaginary), will make the situation perhaps plainer. The diagram, by exaggerating the vertical dimensions with reference to the horizontals, emphasises the danger of the situation and shows how improbable it is that such a theory could be true.

PLATE VIII.



SKETCH OF THE FAYÛM

From Lahûn through Biahmu to Lake Qurûn through the highest plateau, showing Linant's supposed Lake.

It should be noted that the Linant Lake itself covers the richest land of the Fayûm, namely, that which, being near the first point of expansion of the inflow into the depression, had received the richest deposit during the time that the Fayûm was forming previous to the creation of Lake Mæris; and, further, it should be remarked that the remainder of the best land round the margins and for a considerable distance from the Linant lake banks would have been probably ruined by infiltration. Where, then, should we find the rich lands of the Arsinoïte Nome, so famous for their produce?

M. Linant objects (and there is, doubtless, weight in this objection) to the theory of the submergence of the Fayûm by a sufficient elevation of the waters of the Birket-el-Qurûn, that there would be no place for the Arsinoïte Nome; and he thinks that by his theory he has found a place for it between the two rival lakes. The ancient Egyptians, who lived before our era, must

have had prodigious faith in their protecting deities, or in their department of public works, if they took up their abode behind Linant's bank.

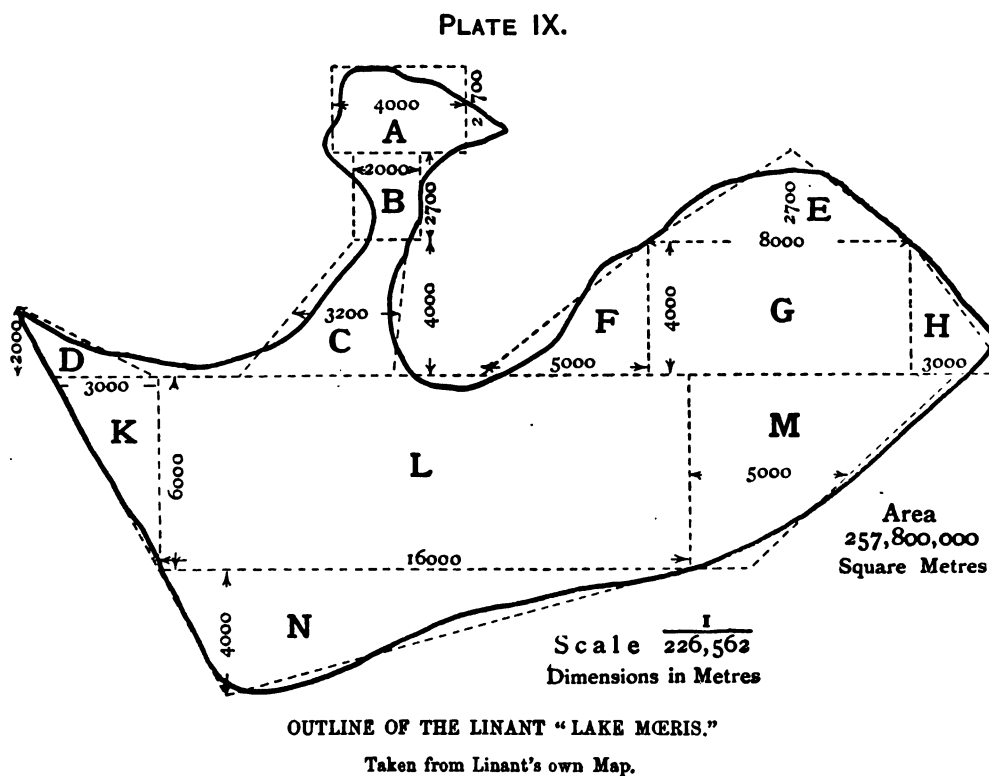
Such a peculiar arrangement of land and water as that supposed, would scarcely have been passed without notice by those who visited and described Lake Möeris. The Arsinoïte Nome would have been in some way described as being between two lakes, with a mass of water impending over it. The danger of such an arrangement in case of a breach would have been surely noted. Imagine also the condition of Arsinoë from its sanitary aspect in the hot months of summer, when by reason of all the water in the Linant lake being utilised, the bed of the lake would be laid bare at a time when no crops could be sown on it. But this objection may be met by supposing the lake to have been excavated to a sufficient depth for water to remain in it at lowest Nile. But if originally so excavated, a lake such as this was supposed to be, would rapidly silt up, and M. Linant supposes it silted up 8 metres, as is shown by his section and description. Could such a lake have continued in working order for over 2000 years, as it was supposed to have done? It would only have done so by means of periodical silt clearances of such magnitude, that the population of Egypt alone would not have been equal to the task. Suppose only a metre to be cleared over the whole area (assuming it a plateau according to M. Linant's view of it), the quantity to be cleared would have been 250 million cubic metres, which would have to have been removed to a mean distance of at least 2000 metres! What would have happened to Linant's supposed Arsinoïte Nome, and the west bank of the Nile irrigated by his Lake Möeris, while these clearances were going on?

The perimeter of Linant's supposed lake is 96 kilometres (60 miles) measured on the map published in the atlas accompanying the book containing M. Linant's theory. Its *correct* area is 257,800,000 square metres. But M. Linant himself gives the area as 405,479,000 square metres, which is 57 per cent. in excess of the true area as taken from his own map (see diagram, Plate IX). The paragraph in which this figure is given concludes: "Mais nous avons vu quelle foi on devait avoir dans les dimensions données par les auteurs anciens." Need he have added "anciens"? M. Linant himself is the greatest argument for placing no faith in reported dimensions of lake areas, since, with his own map before him, and the limits of his lake definitely determined, he was unable to avoid so large an error.

The author of this theory states that it satisfies all the conditions

required for its recognition as Lake Mœris. I think it will be found to satisfy very few, and obviously not the two following, regarding its size and depth.

It is generally stated that Herodotus gave the circuit of Lake Mœris as 450 miles, or 720 kilometres. The perimeter of M. Linant's lake is about



110 kilometres, but he makes the difference less by adopting M. Jomard's opinion, that Herodotus' "stade" was "le petit stade," whereby the circuit of the lake, according to Herodotus, would be 360 kilometres. Even thus we can scarcely admit this condition to be satisfied. But M. Linant, as we have seen, has no faith in the dimensions given by "les auteurs anciens," but though his want of faith may be justified, his statement that this condition is satisfied is not.

Another condition which M. Linant's lake is far from satisfying, is the depth, which Herodotus gives as 92 metres. Linant makes his lake depth 9·60 metres, assuming that his lake area occupies a plateau, which it does not. The greatest depth of his lake, according to the actual levels of the

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ground included in it, would be 18·60 metres, against the 92 metres of Herodotus. This condition therefore is not satisfied.

Faulty Foundations on which the Linant Theory was built.—Had Linant Pasha had before him a contoured map of the Fayûm, I believe he would never have enunciated his theory. The Minia wall made an undue impression on him and has been his stumbling-block. He clearly traced the remains of a large bank from Edwah to Biahmu, and less plainly to Medineh, but after Medineh he found *no traces* of a bank, but being desirous of connecting up with the big wall, *supposed that it must have* passed through certain villages leading to it. This wall, closing a valley encircled by contour R.L. 15·00, was probably constructed at a much later date, or at any rate independently of the bank of which the remains are found on the other side of Medineh, and for a different purpose. If this wall had been originally higher there would be remains of the high parts at each end, where breaches had not carried away the original wall. This we do not find, but on the contrary, the crest of the wall is at one uniform level from end to end, and appears to have been added to, instead of taken from. From an examination of the abutments of the bridge, built in the line of the wall, the original wall appears to have been constructed of stone, and to have been widened subsequently by an addition of coarse brick masonry of rough bricks, in mortar made of lime and clay, probably with the view of obtaining width enough to carry an aqueduct along the top of the wall. None of the masonry is sufficiently good for this purpose, and so, no doubt, the water, leaking from the aqueduct channel, gave rise to breaches in the wall, of which the signs are evident in the blocks of masonry lying scattered about on its downstream side.

The cross-section of the wall, Plate X., gives its dimensions at a point near the bridge, where its height is greatest. Below this cross-section another of the Edwah-Biahmu bank is given for a comparison of the levels of wall and bank.*

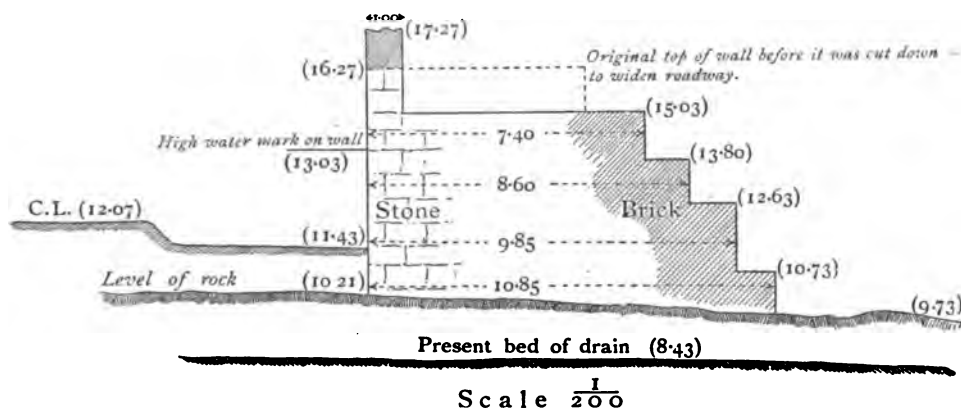
Erroneous Data employed by Linant.—In Linant Pasha's Atlas, published with his Mémoires, is to be found an extraordinary section of the Fayûm from Lahûn to Birket-el-Qurûn, in which the land from Lahûn to Medineh

* I believe the ridge east of Edwah and running parallel to the railway along its south side is natural. Its crest has a decided inclination downwards from the hills on the east of Edwah. The artificial bank begins at Edwah and runs west, but it is joined at Edwah to this natural ridge.

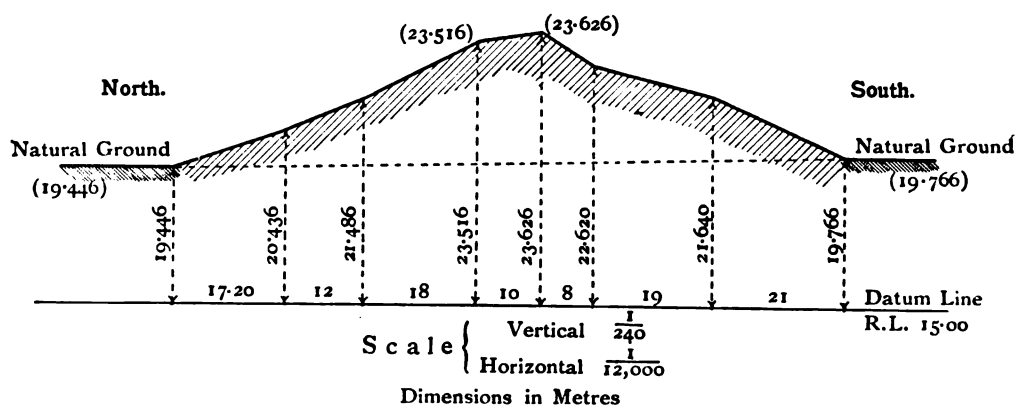
is shown as being higher than the land of Beni Suef on the Nile Valley side of Lahûn.

I reproduce his section on Plate XI., and below it I give a section showing the actual levels. As Linant appears to refer all his levels to the rock bed at Hawârat-el-Maqta, which he makes 32·80 metres above sea,

PLATE X.



CROSS SECTION OF THE MINIA WALL.

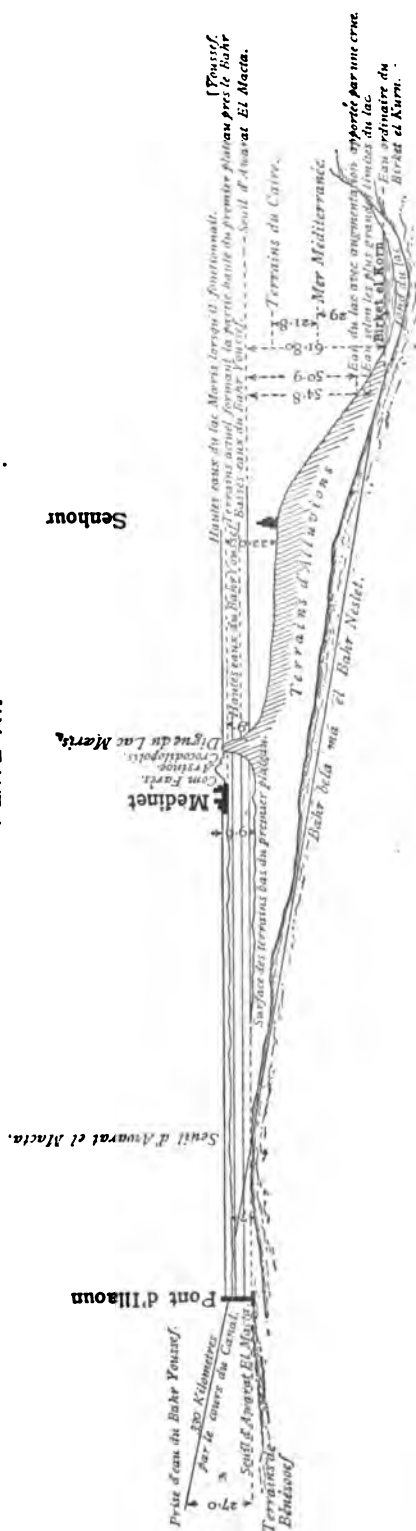


CROSS SECTION OF THE EDWAH-BIAHMU BANK AT A POINT WEST OF EDWAH.

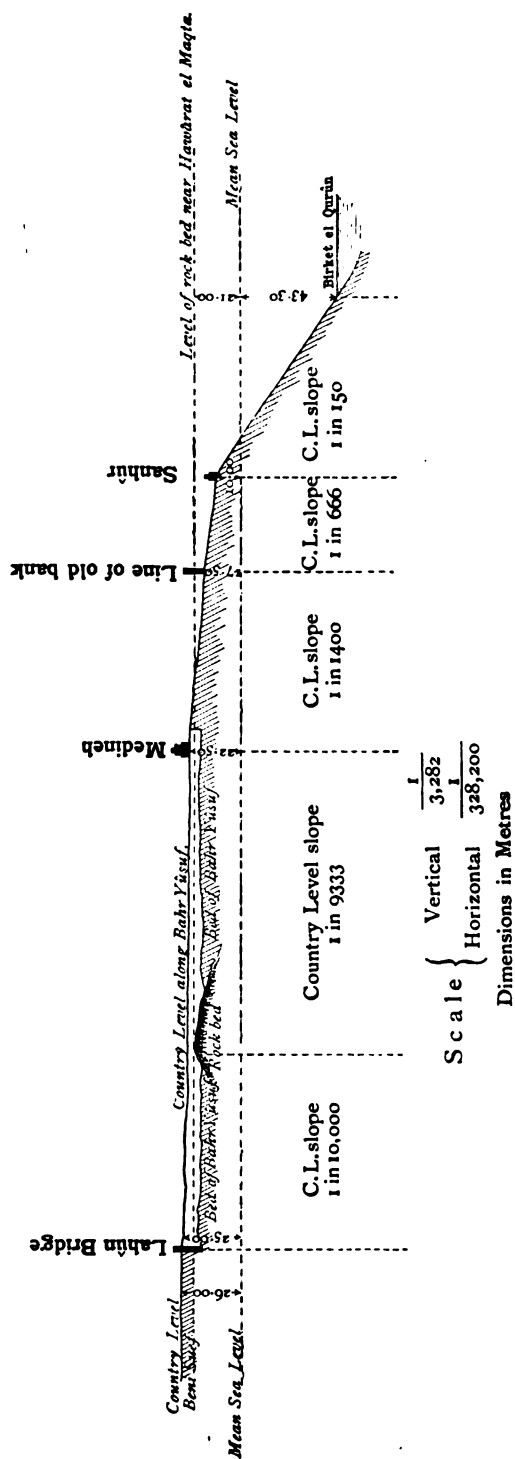
whereas it is really 21·00, it is necessary before comparison to apply a correction of — 11·80 to all his levels.

Comparing the figures after correction with those of the "actual section," it will be found that Linant puts the level of the Beni Suef lands $5\frac{1}{2}$ to 7 metres too low, and that of his first plateau 6 to 8 metres too high, with reference to the rock bed at Hawârat-el-Maqta. According to the

PLATE XI.



SECTION OF THE FAYÛM THROUGH LAHÛN-MEDINEH-SANHUR. By M. LINANT.



ACTUAL SECTION ON THE SAME LINE.

Note.—The water-level of the Bahr Yūsuf from Lahûn to Medineh is a little below country level throughout.

corrected figures his Lake Möeris level would be $+ 32.00$, but how he gets it to that level it is difficult to understand, inasmuch as he says that his lake is filled by the Bahr Yûsuf, whose high-water level is shown $4\frac{1}{2}$ metres lower. (The Birket-el-Qurûn level, after applying the correction, becomes 40.80 , which must have been about its correct level in Linant's time.)

I give another instance of error with reference to Linant's conception of the first plateau. Writing of the bank from Edwah to el Alam, he states that the land to the south of this bank was about 2 metres below its crest, and to the north of it from 8 to 9 metres, which difference, he says, is explained by the deposition of silt in the interior of the basin formed by the bank, as is always seen elsewhere at all the banks of the inundation basins of Egypt. This great difference of level of the country surface on either side of the bank would have been very suggestive in a sense favourable to M. Linant's theory had the difference of level been a fact instead of a fiction. The cross-section of the bank given on Plate X. shows its actual state with reference to the land on each side of it.

It seems scarcely necessary to discuss further a theory that was based on such erroneous data, but as the data were not known to be erroneous, and Linant propounded his theory with an air of authority, it has had considerable success in getting itself accepted. Guide-books, and even books used as school text-books on Egyptian history, show that his theory has been hitherto judged the correct one.

It is, however, satisfactory to find that in the fifth edition (1890) of 'Ancient Egypt' by George Rawlinson (The Story of the Nations Series) the exact size and position of "Amenemhat's reservoir" is admitted to be *sub judice*, and it would appear that this desirable attitude is the result of a challenge of Linant's theory by Mr. Cope Whitehouse, who is reported as believing that the water was freely admitted into the whole of the depression (i. e. the Fayûm), which it filled, with the exception of certain parts, which stood up out of the water as islands from 150 to 200 feet high. Nevertheless, in spite of this new attitude towards the Linant theory, the map representing Linant's Lake Möeris is to be found at the end of the book, without any remark to prevent readers from being misled by it, the map being described as "Map of the Fayoum, showing the Birket-el-Keroun and the artificial Lake Möeris." (Plate VII. is from an earlier edition.)

The Linant theory, examined in the light of the more accurate knowledge gained of the physical features of the Fayûm, and tested by the

application of figures to determine its possible performances, can no longer stand, but falls to pieces; and the wonder is that, based as it was upon erroneous data and propped up by no solid support of facts, it stood so long. It may be said of it, to the credit of its author, that it was ingenious, but not that it was true.

Since writing the foregoing concerning the Linant theory, Mr. Cope Whitehouse has kindly lent me his first papers on the subject, the earliest paper, that I had previously seen of his writings, being that which was read by him at the Manchester meeting of the British Association, September 2nd, 1887. I now find that he has been before me in stating many of the arguments I have used against the Linant lake theory, but it is satisfactory to find that we have independently arrived at the same conclusions, though by no means surprising, as I believe that any one, with the same amount of personal acquaintance with the Fayûm, would be naturally led to hold the same views of this fantastic theory. As early as 1882, Mr. Cope Whitehouse pointed out that the Linant lake satisfied none of the conditions which a lake professing to be Lake Möeris must satisfy, and he concluded one of his papers with a remark expressing his conviction that, when Lake Möeris shall be recognised by the light of discoveries yet to be made through further research, the site of the ancient lake will in no case be found to be that of the reservoir of M. Linant de Bellefonds Pasha.

Mr. Whitehouse, at the same time as he lent me his papers of 1882, also lent me a copy of Dr. G. Schweinfurth's letter to Paul Ascherson on a journey undertaken in the depression of the Fayûm in January 1886, in which letter I find I am anticipated again in a footnote on this theory, which gives an argument not given by Mr. Cope Whitehouse, and runs as follows:—

“Here it must be mentioned that one of the most important points on which Linant grounds his Möeris theory is the Dams* which has proved quite fallacious. The dam at Adwa (Edwah) geology shows to be layers of gravel; the stone dam at Minia is, on the other hand, a weir for the Bahr-el-Wady, and is evidently throughout its whole length of later date. Besides, it fills up only the deep curves of the ground, and has no continuation on the rising grounds.”

Dr. Schweinfurth, as well as Mr. Whitehouse, had thus pointed out the

* Dr. Schweinfurth includes the Edwah-Biahmu bank and the Minia wall under the expression “dams.”

weakness of the Linant theory, but still we find it living and *taught* as a true theory so late as 1890; and this is my excuse for repeating the arguments which have not yet succeeded in overwhelming it, notwithstanding its feebleness, so much support does it derive from its parent being a reputed authority.

But we have public acceptance of the Linant theory so late as 1892, and by so eminent an Egyptologist as Brugsch Pasha, who communicated his views to the Société Khédiviale de Géographie in a paper read in Cairo, on the 8th April, 1892, the title of the paper being "Le Lac Mœris d'après les monuments." A quotation from this will show that he accepts the Linant theory.

"De nos jours, les traces visibles de cet immense bassin d'eau (le lac Mœris) ont disparu et les savants les plus distingués se sont en vain efforcés pendant longtemps de retrouver ses anciennes limites sur le sol moderne de la province du Fayoum.

"L'opinion la plus généralement acceptée au sujet de sa position a Linant pacha pour auteur. C'est lui qui, le premier, a rejeté l'idée de reconnaître le bassin du lac Mœris dans le Birket-el-Kouroun de nos jours, c'est-à-dire 'le lac des Cornes,' situé comme on sait, à l'ouest du Fayoum. Suivant les recherches très minutieuses de l'illustre savant, il faudrait, au contraire, se diriger vers le côté oriental de la province susnommée, et, notamment, vers les plateaux bien connus de Hawara et de El Lahoun, où deux pyramides construites à l'époque de la XII^me dynastie (vers 2500 a. J.C.) excitent encore la curiosité des voyageurs.

"H. Lepsius, mon savant compatriote qui, il y a presque cinquante ans, a eu l'occasion d'examiner sur les lieux les résultats obtenus par Linant pacha, n'a pas hésité à déclarer dans un Mémoire spécial que le savant français avait fait la découverte la plus brillante et la plus indubitable quant à la véritable position topographique du fameux lac Mœris. Les doutes qu'il exprima à la même occasion ne s'appliquaient qu'à l'extension du lac vers le nord.

"Depuis Linant et Lepsius, aucun savant sérieux, du nombre des géographes et des Égyptologues, ne s'est opposé à l'opinion émise par ces deux illustres auteurs."

Apparently Brugsch Pasha does not class Dr. G. Schweinfurth, Mr. Flinders Petrie, and Mr. Cope Whitehouse as "savants sérieux," for they have expressed themselves as opposed to the Linant theory. Lieut.-Colonel

J. C. Ross, C.M.G., late Inspector-General of Irrigation, Egypt, justly renowned for his power of comprehension of the levels of any part of the country, which he studied professionally, at one time gave much of his attention to the Fayûm, and especially to that part which was known as Hod-el-Tuyûr, and which is the depression embraced in the area which Linant calls a plateau and in which he localised his supposed Lake Mœris. I think I may say, without fear of contradiction, that Colonel Ross's examination of the ground in question was much more thorough and more prolonged than that of M. Lepsius; but whereas the latter did not hesitate to accept Linant's theory and to style it the most brilliant and certain discovery as regards the position of Lake Mœris, Colonel Ross on the contrary rejects Linant's theory and thinks that the lake was north of the Edwah bank and not south of it.

Mr. Petrie has also clearly expressed the same views as Colonel Ross on this point.

I too have had advantages of studying the ground itself and the way the water runs, such as few have had, and have come in for the legacy of Colonel Ross's levellings and maps.

The names of Linant and Lepsius do not therefore carry with them sufficient authority to override the facts, which are ascertained to be such by a more thorough examination of the country and a better knowledge of the physical features of the province.

Irrigation officers may, perhaps, not be classed as "savants," but they have at least as much right to be heard as any other body of experts on such a subject as Lake Mœris, which is more than anything else an irrigation question, and one that has especial interest of a more or less practical nature at this time, when the question of the construction of Nile reservoirs for the storage of the surplus waters of the Nile is under consideration.

COPE WHITEHOUSE THEORY.

Mr. Cope Whitehouse, who has a personal acquaintance with the Fayûm, and has studied the question of Lake Mœris, though with a prejudice in favour of giving the Wadi Raiân a leading part, would possibly have been inclined to hold the same views as I do, had it not been for his anxiety to recommend the Wadi Raiân for future use by magnifying its imaginary

past performances. But as his views about the Wadi Raiân are the essential and distinctive part of his theory, we do not agree.

For ten years Mr. Whitehouse has been brooding, as the faithfulest of mothers, over his theory, looking for a practical project to be hatched therefrom, but, as time passes, he begins to show signs of impatience, and fears lest his egg be addled. The possibilities as to what the chick may be when it appears, are set forth in Chapter V. of this paper, for I cannot but think that the egg is a good one.

Mr. Whitehouse believes that in prehistoric times, before artificial works of control were made, the Nile flowed into and submerged the whole Fayûm, which was filled at high Nile, and that when the flood subsided, the return flow, that took place from the Fayûm to the Nile, prolonged the period of inundation by at least two months. He also believes that the river flowed in a single channel along the eastern desert.

So far most of us who have our theories about the Fayûm travel together, with but small differences on the way. But after this our roads diverge, and each thinks the road he has selected leads to Lake Möeris. But they cannot all go there.

Leaving prehistoric times, and coming to the period of ancient history, Mr. Whitehouse holds that there were two lakes. At first the northern lake, the Fayûm, was a lake and marsh serving as a backwater to the Nile, while the southern, the Wadi Raiân, was dry. So far I agree with him, but now we part company. Subsequently, he imagines, engineers of an alien race diverted the flood waters into the dry Wadi Raiân to the south-west and evaporation dried up the Fayûm, which was then irrigated by a system of canals. The Wadi Raiân basin becoming full served as a reservoir, and was, according to Mr. Whitehouse, the "Möeridis Lacus" of Ptolemy.

Later on, in 1890, Mr. Whitehouse explains his views in terms which are not quite in agreement with the foregoing, for he then supposes that the natural backwater of the Nile included the Fayûm and Wadi Raiân (with its minor basins Wadis "Safir" and "Lulu") at one and the same time, and that these combined basins were filled to the level of high Nile, which he puts at R.L. 30.00.

I think, however, his present views are, that at first the Wadi Raiân formed part of the Lake Möeris of Herodotus, of which the Fayûm was the main part; and that afterwards the Wadi Raiân alone formed the "Möeridis

G

Lacus" of the Ptolemaic maps, the Fayûm having been brought under cultivation, after its waters had been dried up by evaporation.

As the Wadi Raiân is the prominent feature of this theory, I will give here in full Colonel Western's official description of it:—

Description of the Wadi Raiân.—"This valley or depression in the Libyan Desert, discovered by Mr. Cope Whitehouse in 1886 (really three or four years earlier), lies immediately to the south-west of the Fayoum Province, but separated from it by a range of low hills, 2 kilometres in width and with heights of about 40 metres above sea-level. Two passes, however, leading from the Gharak basin, with level of + 26 metres, have been found in this dividing range and, except for these two passes or entrances, the Wadi is everywhere bounded by hills of at least + 36 metres.

"The soil of the Wadi is for the most part composed of desert sand and pebbles overlying in places a yellow clay, but this desert sand is for about one-sixth of the area hidden by drifting sand-hills or ridges rising some 5 to 10 metres above the general plain.

"Towards the south of the Wadi there are two fresh-water springs; and near these a few date-trees and some brushwood grow.

"The deepest level of the Wadi Raian reaches 40 metres below sea-level.

"To the east of the Wadi, and connected at a level of + 55, is the Wadi Muellah, a valley about $1\frac{1}{2}$ kilometres wide and 7 long. Its lowest depression is at + 25.

"In the Wadi Muellah there are ruins of ancient buildings, and a fair amount of coarse vegetation near them.

"Another small depression, also connected with the Wadi Raian, has been found lying to the south of the Gharak basin of the Fayoum, and only separated by a ridge at level + 35, and 1 kilometre in width. This depression is some 10 kilometres in length by 4 mean width, and has a bottom at about + 15 metres."

Now, there is no evidence whatever that the Wadi Raiân had ever any possible communication with the Nile except by way of the Fayûm depression through the two gaps in the encircling walls of the Wadi, the sills of which are stated by Colonel Western to be at R.L. 26·00, but which later surveys, not yet published, show to be one at R.L. 26·00, and the other at R.L. 27·00. The Wadi Muellah, on first inspection of the map, appears to offer the most likely line of communication with the Nile Valley, but

an examination of this Wadi at its upper end towards the Nile Valley gives no evidence of any such communication having ever existed.

What seems a conclusive proof that the Wadi Raiân was never in *direct* communication with the Nile Valley, is the total absence of all trace of Nile deposit within the limits of the depression.

If the muddy waters of the Nile in flood entered a lake 60 to 70 metres deep, the silt would be deposited and remain, for the return flow from the uppermost stratum back into the Nile would disturb none of the Nile mud brought in. After a long succession of such annual deposits, the depth of deposit would be considerable. In the Fayûm entrance we find such a deposit up to R.L. 25·00, and it is to be noted that the Wadi Raiân was supposed by Mr. Cope Whitehouse to have been in working order, as Lake Mæris, after the Fayûm ceased to be so, and therefore there would have been less time for the disappearance of the Nile deposit of the Wadi Raiân than of that of the Fayûm.

In the Wadi Raiân, Nile deposit has *not* been found, though eagerly looked for. I think this fact is fatal to Mr. Cope Whitehouse's theory of a *direct* communication between the Wadi Raiân and the Nile or Bahr Yûsuf.

Dr. Schweinfurth thus expresses his views as regards fresh-water deposit in the Wadi Raiân :—"The basin (Wadi Raiân) exists, but it comes from geological time, does not belong to the Nile, and offers nowhere in its tracts at some distance from the Fayûm any trace of a fresh-water formation. . . .

"The traces of a settlement of water and layers of Nile earth which are said to exist in some parts of the depression are certainly absent. The grey clay-layers of the old sea with shells of fresh water, innumerable fish vertebrae, bones of tortoises, &c., are not to be overlooked where they exist. I could prove such fresh-water formations on the road from Talit over Raiân and Medinet-el-Bahrî (27 kilometres to the west of the actual lake) only at a distance of 8 kilometres from the lake (Birket-el-Qurûn). The yellow Eocene marls with stripes of erosion, results of the wind, moving sand, and of periodical rains, are not to be confounded with these lake formations. A man who does that will find traces of old water and Nile earth everywhere in the deserts of Egypt."

Later on in the same letter he says that the question, whether fresh-water formations exist in the basin of Raiân or not, is to be answered in the negative.

But supposing an *indirect* communication with the Nile by way of the Fayûm Lake, it is easy to understand that no Nile deposit would be found in the Wadi Raiân, even if it had been thus repeatedly filled, because the top water only would begin to spill over into it after the Fayûm Lake level had risen above R.L. 26·00, and after the water had travelled at an extremely low velocity to a long distance from the point, at which it first spread itself out in the Fayûm Basin.

But I regret, for the sake of Mr. Cope Whitehouse's feelings, that even this cannot be admitted to have taken place, for in every situation where Nile water has been, fresh-water shells of distinct species are always found, and their total absence in the Wadi Raiân is sufficient proof to geologists that Nile water has never been there.

To the conclusion that the Wadi Raiân was never in *direct* communication with the Nile must therefore be added this further conclusion, that the Nile water *never* entered the Wadi Raiân *at all*, even by the only possible entrances over the sills on the side of the Fayûm Lake.

Mr. Cope Whitehouse has not distinctly stated how he supposes the Wadi Raiân was put into direct communication with the Nile, but I believe there are only three possible theories, each one without a particle of evidence to support it. One theory supposes a connection along the bed of the Wadi Muellah, another a tunnel through the hills dividing the depression from the Nile Valley, and the third a hill-side canal fed from the Nile waters entering at Lahûn and carried along the south slopes of the Fayûm.

In the absence of any evidence witnessing to the previous existence of such connections, and in the face of the fact that the Wadi Raiân contains no Nile deposit, I do not think that Cope Whitehouse's Raiân-Mœris or Ptolemaic-Mœridis-Lacus theory can stand.

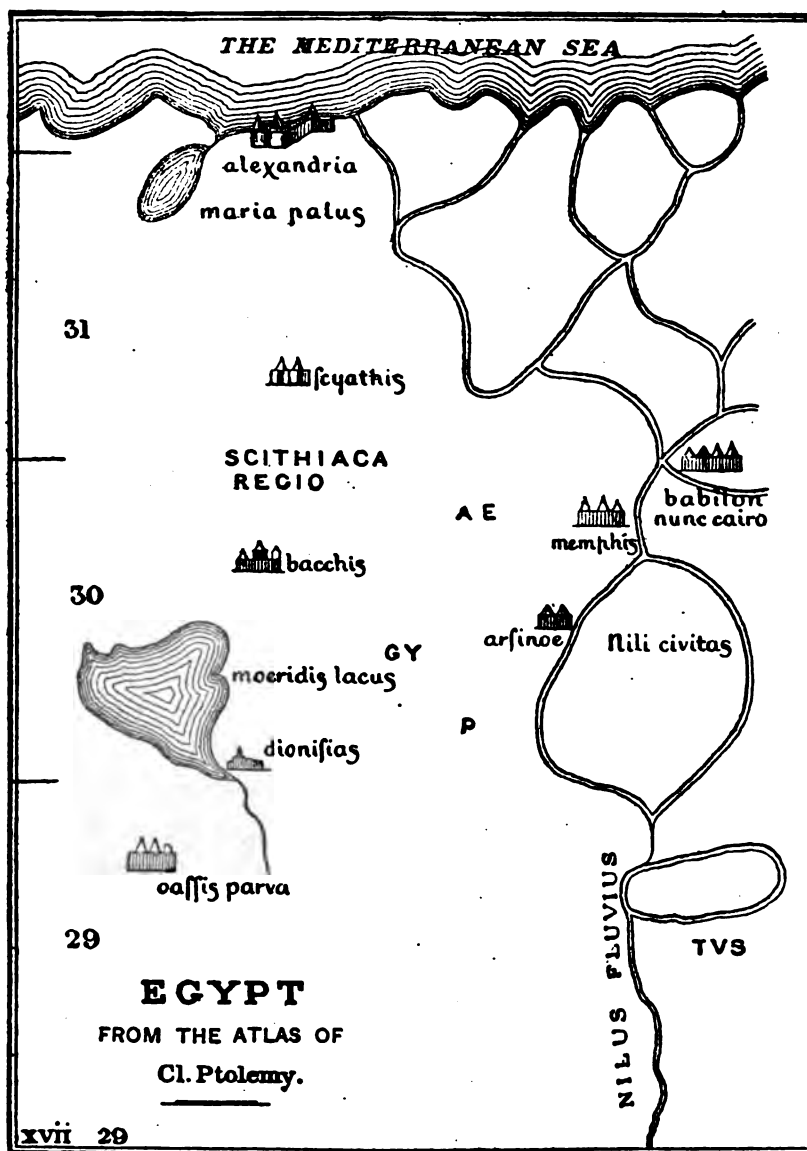
Failing better support to his theory, Mr. Whitehouse has called the Ptolemaic maps to his aid, and in his pamphlet on the subject he has reproduced the map of Egypt from the Atlas of Cl. Ptolemy, of which I here repeat the copy, with an outline map of the Fayûm, Wadi Raiân, and part of the Nile Valley, taken from 'Egyptian Irrigation,' by Willcocks, and which was compiled from the latest surveys in 1888 (Plates XII. and XIII.)

Mr. Whitehouse considers that the Ptolemaic map has been most accurate in giving the exact shape of a lake in the desert, whereas the representation of the features of the much better known Nile and Nile Valley

is evidently most incorrect, and much distorted in longitudinal and transverse dimensions.

If, however, any argument can be based on the shape of the "Mœridis

PLATE XII.



Lacus" of Ptolemy, as compared with existing depressions, it seems to me that its shape resembles much more closely the outline of the Fayûm

Province, with the Bahr Yûsuf indicated, than it does that of the much indented Wadi Raiân.

Mr. Petrie has furnished me with the following observations on the Ptolemaic maps.

PLATE XIII.



Stanford's Geog. Estab. London

PROPOSED WADI RAIÂN RESERVOIR.

From Willcocks' 'Egyptian Irrigation,' 1889.

The Ptolemaic maps are built up from itineraries and ship routes, checked by a few latitudes. Now we know this much from Ptolemy, that

Skiathis, Bakkhis, Dionysias, the Small Oasis and the Great Oasis were on one route, and that on this route Lake Mœris was passed. This was the desert itinerary from Alexandria to the Great Oasis.

Using another distinct itinerary from the Nile Valley, the route passes to Arsinoë (the modern Medinet-el-Fayûm) and Ptolemais (the modern Talit), and then on to Behnesa, without any connection being made with the Bakkhis-Dionysias route. Hence it is presumed that these two routes did not cross each other. It is therefore concluded that Dionysias can be identified neither with the ruins on the Wadi Muellah (as Cope Whitehouse identifies it), nor with Lahûn, and that it was probably on the west of Lake Mœris. Mr. Petrie (to whom I am indebted for the whole of this reasoning) supposes Bakkhis to have been at Dimeh (Dimay), and Dionysias somewhere at the extreme south-west of the Raiân valley.

If this conclusion is right, and if the Fayûm, or the Wadi Raiân, was the Lake Mœris of Ptolemy, the Lake has been placed too much to the west on the map, and should have been shown on the east of the line joining Bakkhis and Dionysias. In any case the Ptolemaic evidence, when sifted, does not support Cope Whitehouse's theory, that the Wadi Raiân was the "Mœridis Lacus" of Ptolemy.

To show what little faith can be put in the identification of some of the ancient towns with modern remains, I may mention that Dr. Schweinfurth says of the monastery in the Wadi Raiân, that it is "evidently the Bakkhis of Ptolemy." Thus we have this monastery identified as Dionysias by Cope Whitehouse, as Bakkhis by Dr. Schweinfurth, whereas Flinders Petrie places both Dionysias and Bakkhis on the far side of the Fayûm depression. Who shall decide when savants disagree?

In his papers on Lake Mœris, Mr. Whitehouse makes reference to *two* lakes, and I believe his theory of two lakes is based on some ancient maps.* I have not seen the map or maps, but I should expect the lakes represented to be intended for Lake Qurûn in the Fayûm, and a corresponding lake in the Gharaq basin. The Gharaq basin is the Fayûm depression repeated on a small scale, and at some period of its development towards total reclamation from the waters that covered it, it must have had a lake at its south and lowest end, corresponding to the Birket-el-Qurûn, but of smaller dimensions.

* Probably that of Fra Mauro, of 1459 A.D., which, as Mr. Cope Whitehouse states, in a paper published in Paris, represents two small lakes unnamed, of which that on the south is larger than that on the north.

The Gharaq basin is connected with the Fayûm depression by a gap in its surrounding higher lands with sill at R.L. 16·00. Consequently the basin would not have begun to dry up from evaporation till the Fayûm Lake had fallen below R.L. 16·00, and probably the fall was not continuous, but, through some accident at Hawârah or elsewhere, the Fayûm Lake, after falling below R.L. 16·00, may have risen again and re-drowned the reclaimed land in the Gharaq. This may have occurred more than once, and have given rise to the name "Gharaq," or the "Flooded."

Mr. Whitehouse, in his latest expression of views, supposes the Fayûm and the Wadi Raiân were filled to R.L. 30·00. I have given reasons for concluding there was never any Nile water in the Wadi Raiân. The evidence furnished also by Nile deposit and fresh-water shells on the Fayûm side of the entrance at Lahûn shows that the level of 30 was never reached.

The highest Nile deposit near and on the Fayûm side of Lahûn is at about R.L. 26·00. The highest in the Fayûm near the Hawârah pyramid, which is on the edge of the Fayûm basin, is at R.L. 24·50 or thereabouts. The highest level of the lake was probably never more than one metre above this level, and it is therefore almost certain that the water-level was never sufficiently high to flow into the Wadi Raiân; and *if* it ever did, it must have been but rarely, when extraordinarily high and prolonged Niles occurred; so that it must be concluded, if my views are correct, that the normal condition of the Wadi Raiân was then, as now, that of a dry waterless depression in the desert, and it cannot therefore be considered as having been Lake Mœris, or a part of it even, *at any time*.

LINANT'S OBJECTIONS TO THEORY FAVOURED.

Author's Views of Lake Mœris generally stated.—I myself agree with those who are of opinion that the Fayûm Province, or depression, (including the Gharaq Basin and the neck from Lahûn to Hawârah), was by itself Lake Mœris, and that within its limits and along its borders was to be found the inhabited and cultivated region known as the Arsinoïte Nome, which possibly also extended into the Nile Valley along the course of the canal connecting the Nile with the lake.

The Fayûm then in its submerged state was, I believe, the Lake Mœris

of Herodotus, Strabo, Diodorus, and Pliny, the modern Lake Qurûn being the persistent rudiment of this lake, and all that now remains of its formerly extensive sheet of water. (See Plate XX.)

Objections urged by Linant against these views.—This is no new theory. It is found *passim* before Linant Pasha in 1842 took great pains to point out its absurdity, but it was his own assumptions regarding the maximum height which the water surface of Lake Qurûn could have reached, that created the absurdity. Assuming without evidence that the villages on the second plateau were all in existence at the time of Lake Möeris, he limits the level of Lake Qurûn to the edge of the second plateau, which is the same thing as laying down that its water surface never rose above R.L. + 10·00.

Having come to this conclusion, he might have spared himself all his arguments against the theory, other than that which pointed out that a reservoir in the Fayûm at this level could have been of no utility in supplementing the low waters of the Nile.

It is, however, instructive to note how he deals with the arguments against this lake, which his imagination set bounds to, being Lake Möeris. After a separate review of each condition which Lake Möeris should fulfil and which the limited Lake Qurûn did not, he closes his reviews with the remark that "we may then conclude that Birket-el-Qurûn is not the Lake Möeris." But he does not do so *always*. Should the condition be one with which his own theory is not in agreement, he explains it away or discredits it. The dimensions assigned to Lake Möeris by the ancient historians evidently trouble him, and he does his best to discredit their testimony on this point. After discussing this condition, he does not end his argument with the usual conclusion that "the present Lake Qurûn cannot be Lake Möeris," but he says "an absolute importance must not be attached to all these measures in order to draw from them conclusions either positive or negative as to the identity of the position of Birket-el-Qurûn with that of the ancient Lake Möeris."

The depth assigned to Lake Möeris also gives rise to the following remarks, which will afford the means of judging of the value of M. Linant's arguments. He states that Herodotus gives the depth of the lake at 92 metres, and remarks that if the whole Fayûm had been filled to form the lake, its dimensions would have surpassed by ten times the greatest given for it.

But as a matter of fact, they do not even *come up to* the greatest

H

dimensions given, which are, for the depth 92 metres, and for the perimeter of the lake 720 kilometres (450 miles), or, assuming as he does that Herodotus made use of the small stadius, 360 kilometres. Now the perimeter of the Fayûm is 220 kilometres, and if that of the Wadi Raiân is added, namely 200 kilometres, the total perimeter becomes 420 and that figure is only obtained by measuring the indentations of the Wadi Raiân, which is of a peculiar shape.

The depth of the Fayûm Lake, if filled to say R.L. + 25·00, would be not less than $(25·00 + 43·50 + 5·00 =) 73·50$ metres, nor more than 88·00 at the highest estimate.

These dimensions agree approximately with those given by Herodotus, and are not, as rashly stated by Linant, ten times in excess.

To show with what unfairness Linant deals with statements made by Herodotus, his arguments about the bricks made for the pyramid built by Asychis may be noted. It was stated that the bricks were made from mud brought up from the bottom of the lake. Linant claims this statement as supporting his theory, as his lake was a shallow one, and as opposing the enlarged Lake Qurûn theory, as this latter would be a deep one. It does not seem to strike him that the workmen could have sought their mud along the shallow margins of the larger lake. He further argues that one could not reach down more than 4 metres with poles, and therefore the lake could not have been so deep as stated by Herodotus, and hence Herodotus contradicts himself! But Herodotus did not say that the lake was 92 metres deep all over, and that its shores were not shallow, but that its *greatest* depth was 92 metres.

Linant Pasha discussed the possibility of the submerged Fayûm being the Lake Mœris, but rejected the idea, because, to fulfil the condition of supplementing the low Nile, the water must have covered the second plateau, and risen to a level above the rock sill at Hawârah (R.L. 21·00). "Then," he points out, "the whole Fayûm would have been only a vast lake and with a height of water impossible to reconcile with the existence of large towns, which formed the rich Crocodilopolite or Arsinoïte nomes. The great quantity of ruined towns, abandoned like Medinet-el-Mahdi, Medinet-el-Hêb, Medinet Nemroud, Kasr Keroun, indicate, as well as those which still exist, as Sanuris, Sanhur and all the others, that this part has never been under water, and they date from the time of Lake Mœris and of Crocodilopolis." (Earlier in his book he states about Kasr Keroun, "Kasr Keroun is a little

PLATE XIV.



OLD BUILDING ON NORTH SIDE OF LAKE QURÛN.
DISCOVERED BY DR. SCHWEINFURTH IN 1884. EXTERIOR FROM NORTH-EAST.

monument, quite modern as compared with the epoch of the Labyrinth." Mr. Petrie and Dr. Schweinfurth both state that Qasr Qurûn is a Roman temple or town.) M. Linant continues, "If ever the Fayûm has been under water, as we have supposed it, it was long before it was habitable and before the Lake Mœris existed."

Now as regards the modern villages of Sanûris, Sanhûr, and others, I am not aware on what evidence M. Linant states that they existed at the same time as Lake Mœris. As regards the old abandoned towns mentioned, some of them are on elevated spots, and probably were on the shores of Lake Mœris. When Lake Mœris declined and the water had receded to a distance from them, they were abandoned for more favourable sites, less remote from a water supply and water transport. Probably Sanûris and Sanhûr, and the other villages on the edge of the second plateau, are the successors in time of the ancient elevated towns mentioned as ruined and abandoned.

Thus, instead of considering the remains of the old high-level abandoned towns as evidence destructive of the theory that the whole Fayûm was filled with water, I consider their testimony distinctly favours such a theory.

Those towns especially, whose ruins are found on the *north* side of Lake Qurûn, would certainly have been built near the then borders of the lake, as they could have had no possible source of water supply other than the lake itself. It, therefore, is a matter of great interest to determine the levels of any ancient towns that may be found on the north of the lake; and the more ancient the town and the more remote from the present lake, the more suggestive will be the facts that may be ascertained with reference to its levels.

Now there are two monuments of antiquity known in such a situation, namely, the ruins of Dimay (Dimeh or Dimé) and an ancient temple (if it is a temple) discovered by Dr. Schweinfurth 7 or 8 kilometres north of Dimay.* Dimay itself is 3 kilometres from the nearest point of the present Lake Qurûn, and the surface of its causeway or quay at its upper end, near the old town, is 69 metres above the water surface of the lake (May 2nd, 1892), or at R.L. + 25·44. The south end of the quay is now about 2·85 metres lower, but it was doubtless originally somewhat higher than this, as its present is not apparently its original surface, some of the layers of stone having disappeared.

I had a trench dug against this quay or causeway, at about the middle

* See map at end.

of its length, to determine the depth to which the masonry was carried down.

If this had been merely a causeway, it is not easy to understand the necessity for so great a depth of masonry. It was therefore more probably a quay projecting into the water. This quay is 400 metres long, and its direction is due north and south. The level of the plateau sloping up to the end of the causeway on the south of Dimay is from R.L. 13·00 to 17·00; the plateau on the north side of the ruins is at R.L. 21·45.

The ruins of Dimay are Roman on the surface, but I do not know if it has been established that below the Roman remains there do not exist more ancient ones. Dr. Schweinfurth thus expresses his opinion about this old town: "Dimé seems to have filled the position of 'tête-de-pont' in relation to the Fayûm, as in consequence of its strong position, it afforded a secure outlet and final station for the caravan road opening out towards the Oasis. That the tribes of the Libyan Desert must even in the times of the Romans have been very restless and enterprising, is testified by the numerous similar fortifications, which in the day of the so-called good emperor, were erected on all the principal exits and entrances to the Oasis roads."

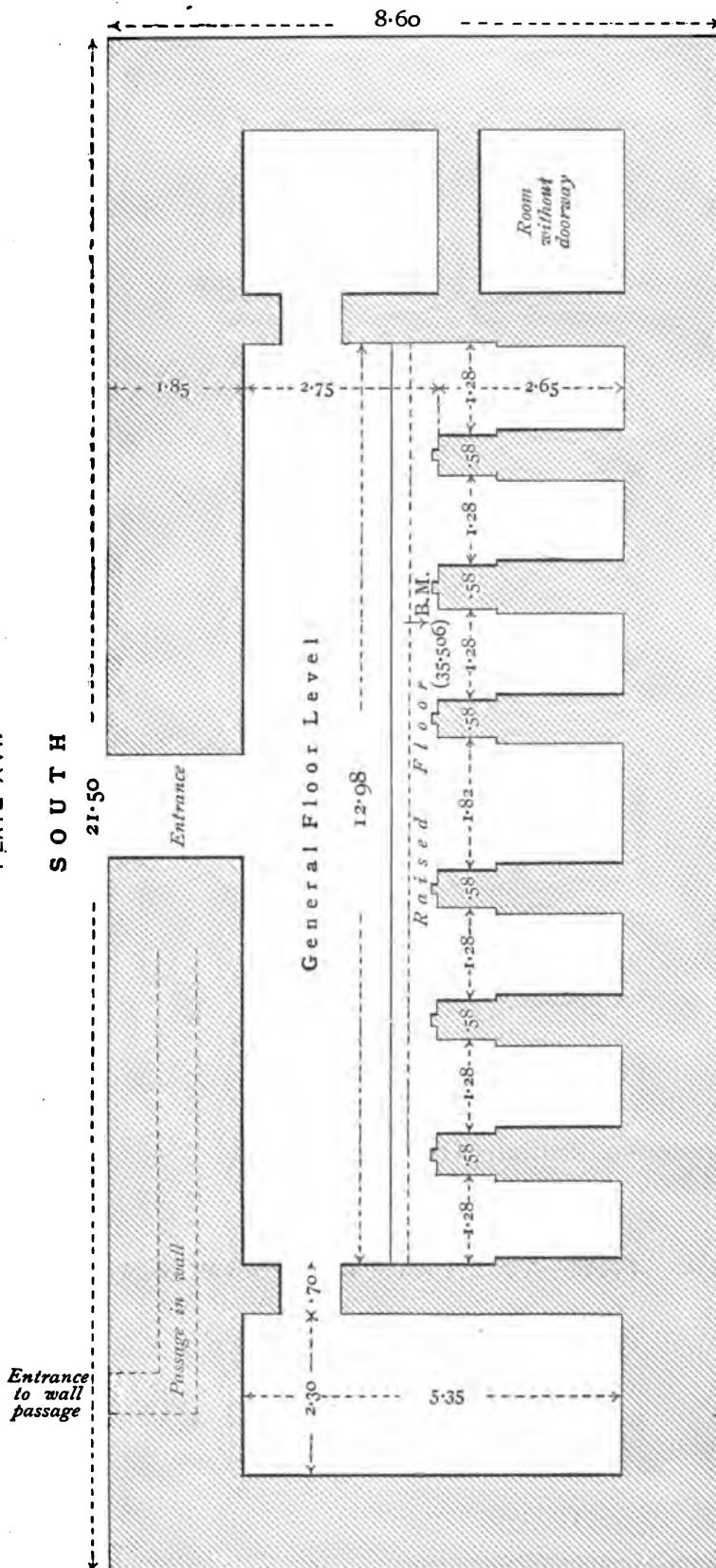
Seven or eight kilometres north of Dimay (magnetic bearing from north entrance in Dimay enclosure wall 12° east of north) is found the ancient so-called temple, discovered by Dr. Schweinfurth in 1884. I give here photographs of the exterior and interior of the building, as well as its ground plan, that those who are capable of judging may have the means of estimating from them its probable age. (Plates XIV., XV., and XVI.) The important level, so far as the subject of this paper is concerned, of the old town, marked by mounds of ancient pottery on the south of the "temple," was determined on the occasion of my visit. The level of the upper parts of these mounds was found to be R.L. + 24·58. The pottery was, of course, spread out to lower levels, but probably the ancient town was built between the levels of 23·00 and 26·00.

Dr. Schweinfurth remarks that the buildings dating from the XIIIth Dynasty are all distinguished by the same kind of four-cornered arrangement as this temple and generally scorn every kind of ornament; and he notes that the great size of the blocks and peculiar method of fitting the stones together give it a resemblance in style to other old buildings. Instead of giving his further description, I refer to the ground plan and photographs. It is worth noticing that the north-west room has no visible means of



INTERIOR OF DR. SCHWEINFURTH'S "TEMPLE."
FROM WEST END OF OPEN ROOM.

PLATE XVI.



NORTH

PLAN OF OLD BUILDING DISCOVERED BY DR. G. SCHWEINFURTH IN 1884.

Height of chambers from surface of raised floor to ceiling 2.65. Scale $\frac{1}{100}$. Dimensions in metres.

communication either with the exterior or with the other chambers of the building; also that the displacement of the stones, forming the upper half of the chambers on the raised floor, is suggestive of an earthquake, the upper stones having slid on the lower to a measurable extent in a north-easterly direction. Cracks in the roofing stones corresponding with the displacement seem to confirm the theory of earthquake action.

The object of the building is a riddle. Each of the raised cells has a recess for a door. "In the thickness of the south wall, on the east side of the principal entrance, runs a passage half a metre wide, leading to which, at the south-east corner of the temple, a door of equally narrow proportions is attached. This passage leads downwards to the chambers below" (Schweinfurth). Dr. Schweinfurth came to the conclusion "that the old temple, as well as the original settlement or formation, is one of the monuments belonging to the oldest times."

Concerning the old town he writes:—"In the neighbourhood of the temple, from south-east to south-west, at a distance of about 500 paces, that is, on the edge of the rising ground, there are quantities of potsherds lying in heaps here and there. They are of the most weather-worn appearance, and have formed portions of coarse, thick vessels. No such things as fragments approaching the pottery work of the Greek or Roman period are found. The eye of the seeker sought in vain for remnants of that blue glazed pottery ordinarily so common, or the long amphoræ of the Greek shape.

"The amphoræ points or ends, which I picked up, were all stumps, and of an almost cylindrical shape. The corresponding pottery showed no sign of rings. They were almost entirely coarse, red clay fragments, with here and there a yellow or black bit, and all distinctly showed the work of the potter's wheel.

"Below the scarp of the lowest rising ground no more pottery was to be found, neither did the marl mounds display on examination any admixture of manufactured pieces. The heaps of pottery formerly existing appear to have been flattened down and spread out over a much wider space by the disintegration and sweeping down of the marl bed. A similar occurrence may be observed on the few stone walls yet remaining of the old temple settlement."

For Schweinfurth's further remarks see pp. 101 to 107 of his velocigraphed letter to Paul Ascherson on his journey in the depression of the Fayûm, 1886.

The line of levels, which I had taken between this old building (temple) and Dimay, followed a direct line between the two, crossing the elevations and depressions given in the list below:—

From Schweinfurth's "Temple" to Dimay.

	R.L.
Floor surface of raised chamber on left of central chamber ..	35·506
Pottery mound of old settlement	24·580
First depression on line of levels	9·611
Following elevation	16·521
Second depression	6·096
Following elevation	14·461
Third depression	7·716
Plateau north of Dimay	21·448
On ruined mounds in Dimay enclosure	28·368
Causeway at undamaged upper end	25·438

From Dimay to Lake Qurûn.

Causeway	25·438
Plateau north of Dimay, upper end	17·000
" lower end	13·270
Fossils plentiful between	— 3·500
and	— 13·000
Water surface, Lake Qurûn, May 2nd, 1892	— 43·540

These levels I am convinced are correct, as they were taken with the utmost care, as I myself saw, by Messrs. W. O. Joseph and A. Pini, who had been in constant practice at levelling. The levels between Lake Qurûn and Dimay were taken twice over; the first levels, taken by Monsieur Pini alone, giving a difference of level between the lake and causeway of 68·952 metres, while the difference found, when both read, was 68·978.

The levels for the old town near Schweinfurth's "temple" having been found to be from R.L. 23 to 26, the theory that Lake Mœris was a little below the level of R.L. 23·00 is favoured by the determination of this level. The presence and peculiarities of the quay at Dimay, if it is such, and the existence of an old town on the heights where the Dimay ruins stand, if they can be used as evidence of what the lake level used to be, point to high levels rather than to low ones, and do not answer to Linant's appeal to the old abandoned towns to bear witness in his favour.

In connection with the levels of Dimay and Schweinfurth's "temple" the levels of the ruins of Biahmu should be studied. These are given on Plates XXII. and XXIII.

The top of the highest corner-stone of the enclosure wall, now *in situ*, is at R.L. 21·59, and, accepting Mr. Petrie's restoration of these ruins, the top of this wall, when complete, would have been at R.L. 23·00, which would seem to indicate that the maximum water-level of the lake was below R.L. 23·00, but higher than R.L. 17·00, the level of the ground outside the enclosure. These ruins are referred to more fully on p. 83 *et seq.*

Mr. Flinders Petrie's Views of Lake Mæris.—Having discussed the theories of Linant Pasha and Mr. Cope Whitehouse, the only two that I can find stated with any distinctness, and the only ones that have been put forward by travellers having a personal acquaintance with the Fayûm, I will, before setting forth my own reading of the past history of the province and my theory as to its connection or identity with Lake Mæris, first give Mr. Petrie's views, who should be included with the two foregoing theorists, as a traveller having a personal acquaintance with the Fayûm, and, in a special line, a very intimate one. I do not think that he would claim that the expression of his views constitutes the enunciation of a new theory of Lake Mæris, but only his way of viewing an old theory with some side-lights of his own added by way of illumination.

The views, that I have adopted, are in general agreement with those favoured by Mr. Petrie, and as he, an Egyptologist and archæologist, has thrown light on the subject from his standpoint, I propose to make the same attempt from my point of view as the Public Works officer in charge of the irrigation of the Fayûm. The working out of the problem of Lake Mæris would seem to require an alliance between a palæontologist, an archæologist, an Egyptologist, a geologist, and a hydraulic engineer.

The following is copied from 'Hawara, Biahmu, and Arsinoë,' by W. M. Flinders Petrie, published in 1889 :—

"Medinet el Fayûm (Plate XVII.) is the modern town which represents the ancient Arsinoë, so named by Ptolemy Philadelphos in honour of his sister-wife; it lies at the extreme south of the old site, which covers a space of over a mile long and half a mile wide, a vast wilderness of mounds strewn with pottery. At the opposite end of the ruins, toward the north, is the great temple enclosure of the old Egyptian town. Before its name of Arsinoë, the city had obtained the name of Crocodilopolis, from the worship of the sacred crocodiles maintained there; and still earlier it was known as Shed, meaning, apparently, that which is saved, cut out, delivered, or extracted, referring to the district being reclaimed from the great lake. The whole

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VIEW OF MEDINET EL FAYÛM,
WHICH OCCUPIES PART OF THE SITE OF THE ANCIENT TOWN CALLED SUCCESSIVELY "SHED," "CROCODILOPOLIS," AND "ARSINOË."

province was known as Ta-she, 'the land of the lake'; and, whatever may have been the mistakes of historians about Lake Moiris, there is no doubt that the lake was the main feature of the district.

"So many opinions have been broached about Lake Moiris that an account of antiquities in the Fayûm without mentioning it would seem impossible. So, although my work has not been in that line, yet it will be well to state what seems to be the truth about it, in order that some collateral questions should be the better understood. For the following view of the use of the great dyke I am indebted to Colonel Ross, R.E., C.M.G., who has professionally considered the subject. The Fayûm is one of the oases of the Libyan Desert, lying close to the Nile Valley; and the intervening ground is low enough for the Nile to pour into the basin. The fall from the Nile Valley to where the channel widens out into the Fayûm is about 12 feet; and the water flows over the province by canals and ravines, worn through the rock and its superincumbent mud, until the streams finally collect in the Birket Kurûn at more than 200 feet below the Nile level, and, indeed, 130 feet below the sea. The present area of cultivation is about 20 miles in each direction; but the whole basin, geographically speaking, is about 40 miles across on an average. This does not include the secondary basin of the Wadi Raian to the south, which never had any connection with the Fayûm basin in historic times, the ground rising over 100 feet above Nile level between the two depressions.

"In pre-historic times the Nile Valley was full of water to a far greater depth than at present, probably 100 to 200 feet deep of water filled it right across. A river of such a size seems almost incredible, and we naturally should suppose it to have been an estuary; but this must not be too hastily assumed, as there are evidences over the whole country of an enormous rainfall, which ploughed up the cliffs with great ravines; while the bare bed of the old Nile in the eastern desert at Silsileh is some miles in width, showing what a large volume of water has filled it; a lesser stream would have cut down a deep channel in the old bed, and would never have filled that and topped the rocks to force its present cut. This pre-historic high Nile is not, however, pre-human, as I found a palæolithic flint high up on the hills to the west of Esneh, clearly river-worn. The geologic conditions, then, in the pre-historic time prove that the Fayûm Basin must have been a vast lake, connected by a broad arm with the Nile Valley. Thick beds of Nile mud exist beneath 10 to 20 feet of deposits washed down from the

desert hills; and even this desert detritus is strewn with felspar and quartz pebbles brought in by the Nile from Assuan, and now lying high above the present Nile level. As the rainfall ceased, and the Nile fell, the neck of water was reduced, but it still sufficed as a channel for the filling of the Fayûm, in all probability, in the time of the earliest dynasties. The Nile bed has risen, it is true, 4 inches a century by its deposits; and hence at the time of the XIIth dynasty, when it was down to its present volume of water, it probably stood about 14 feet lower than it does now in the Nile Valley; but as the drop to the point of flow into the Fayûm is at present 12 feet below high Nile, and the water-level has risen somewhat there, it is pretty well certain that the Fayûm Basin continued during the early dynasties to receive the inflow of the Nile as it had done for ages before. This, then, was the state in which the great engineering monarchs of Egypt found the province; a basin full of overflow Nile water, replenished at each inundation through a marshy shallow inlet, and with much of its bottom so raised by deposits as to have become almost marsh ground, like the present lakes about the coast.

“Amenemhat I. is the earliest king of whom we have any evidence in the Fayûm. He appears to have reclaimed the site of the capital, Shed, ‘the separated’ or ‘extracted,’ and thus he established ‘the land of the lake.’ The dyke of Amenemhat I. may perhaps be seen in a fragment of an enormous bank which remains on the north of the temple area at Medinet. It cannot be part of the temenos wall, as it is far too thick in proportion; and no king later than Amenemhat I. would need to place a dam so near to the capital. The great dyke noticed by Linant—if indeed it be ancient, which some have doubted—is probably the further reclamation of Amenemhat III., signalised by his erecting at Biahmu two great statues of himself at the projecting corner of it looking over the lake, and flanking the road on either side. That the water was on the lower and not the upper side of the dyke, as Linant supposed, is proved by the levels. For if the area within the dyke had been covered with water as a reservoir, the Biahmu structures would have been submerged some 12 feet; whereas there is no trace of deposited mud on any of the upper stones, nor is the building such that it is likely to have been placed in a depth of water. (See Plates 22 and 23.) The work of Amenemhat III. consisted in reclaiming more land, and damming back the lake to narrower limits, while improving the canals which led in

and out of it, so as to render it more effective in co-operating with the Nile. He thus established Lake Moëris, and his works gave him the credit of being its founder in later ages. In the time of Herodotos the lake still seems to have been kept up to its high level, and if this view be correct, we ought not to find any pre-Greek remains in the Fayûm below Nile level outside of the great dyke; so far as is at present known this is the case. The circumference mentioned by Herodotos as equal to the coast of Egypt, would have been about 130 miles, against 180 length of the coast-line; so this statement is but little exaggerated. The length in stadia is, however, evidently wrong. Apparently under the Persians or Ptolemies the desire to acquire more land in the Fayûm at the expense of the irrigation of the Nile Valley, led to restricting the inflow, and gradually drying up the lake. It was reduced greatly during the Greek period, as the temple of Kasr Kerûn, of Roman age, on the shore of the Birket Kurûn, is 72 feet below Nile level; and Dimeh, a Roman town, is at 69 feet, and has a quay, I am informed, at about 87 feet below the Nile.* The shrinkage of the lake, however, went on until it has now left the Roman quay 130 feet high in the air, and the Nile falls over 200 feet before its waters evaporate from the lake. The present problem is how just to let in enough for cultivation without any surplus, and so still further reduce the lake, and increase the area for crops.

"The general level of cultivated land in the Fayûm has not risen by deposits as in the Nile Valley; the denudation by the rapid drainage into the lake just compensating the rise by deposit which would otherwise take place. The evidence for this is seen on the east side of Arsinoë, where the Bahr Tirseh has cut a clean section of the mounds, and the undisturbed bed of Nile mud beneath the ruins is seen to be at just the same level as the fields at present. Also at Biahmu it is certain that the ground has never been much below its present level, or the foundations would have been washed out; nor has it risen much above the level apparently, as the highest mud on the stones is only three feet over the present soil. The fact seems to be that it slowly rose while the lake was at a high level, until it was about two feet higher; and then it has denuded since the lake was reduced,

* Mr. Petrie's information is incorrect on this point. The quay at its upper end is at R.L. 25.438, as ascertained by careful levelling and check-levelling in May 1892, made by Mr. W. O. Joseph and M. Pini, under my directions.

and drainage set in, until it is now perhaps a foot below the ancient level of the XIIth dynasty."

I have quoted Mr. Petrie in full, as he is reputed to be accurate in his statement of facts, and undoubtedly is so as regards his own discoveries and excavations.

I must now pass on to my own views, and set them forth in more detail.

CHAPTER IV.

HISTORY OF THE FAYÛM PROVINCE—THE FAYÛM BEFORE LAKE MÆRIS.

THE past history of the Fayûm Province was probably the following.

In the beginning, the sea covered the whole of the area which afterwards became the Nile Valley and its bordering hills. By a slow process of upheaval the dry land appeared above the level of the waters, but, in the process, what was formerly the uniform bed of the sea became an uneven surface with heights and depressions and faults.

The Nile Valley, the Fayûm and Wadi Raiân depressions were the ultimate result of this action, the formation of the Nile Valley being completed by the flow of water. At first the upper reaches of the Nile Valley held its waters at a high level by barriers of rock, but in process of time these barriers were cut through, the bed scoured out by the constant flow of water, and the water surface lowered beyond its present levels, to be again gradually raised to the levels of to-day. The lower reaches of the Nile Valley were probably at first occupied by the sea, until the yearly deposit of the floods formed the Delta, and pushed the land thus formed further and further out, forcing the sea to retire. As the surface of the Delta became raised and prolonged by successive annual deposits, the bed and water-surface of the Nile also would have risen with it, until the levels at which the Nile flowed in its lower reaches became those of the present day.

At a point in the hills dividing the Nile Valley and the Fayûm, about 10 kilometres south of Lahûn, near Sidment-el-Gebel, Dr. Schweinfurth found "the indubitable witnesses of a Pliocene sea" preserved in the form of oysters (*Ostrea cucullata* and *Pecten*) in the white sand at about R.L. 60 to 70. (See map and Plate XXI.) The Pliocene sea, he maintains, intruded up the Nile Valley and extended on both sides of it as far as the contours of 60 to 70 metres above sea-level allowed. The place, where the oysters in the white

sand were found, is situated in a flat depression on the plateau of the narrowest part of the hills separating the Nile Valley and the Fayûm. The Pliocene sea flowed here from one depression into the other, and would have succeeded in scouring away the barrier between the two depressions, if it had not been interrupted by a later upheaval or a withdrawal of the sea. In a similar manner there seems to have been made from Lahûn to Hawârah, the present communication between the Nile Valley and the Fayûm by which the Bahr Yûsuf entered to form Lake Mœris, either as an old Nile-arm or as an artificial branch of the natural arm.

Besides this passage, the desert tract on the north of it offers, as breaks in the higher ridge, several depressions, which must have been accessible to the Pliocene sea. The present railway line to the Fayûm crosses the hills at one of these depressions.

On account of the regularity of the limestone strata in the Fayûm and Wadi Raiân, a violent upheaval cannot be supposed to have been the cause that produced these two depressions, and it is more likely that they are the results of erosion and scour.

In a passage I have already quoted from Mr. Petrie's writings, he states that in prehistoric times the Nile was a vastly greater river than it is now, due to an enormous rainfall. Let us then assume the Pliocene sea-level at R.L. 60 to 70, according to Dr. Schweinfurth, and an enormous volume of water coming down from the Upper Nile Valley according to Mr. Petrie. The sea which then invaded the Nile Valley would have been in communication with the Red Sea, and may have had a tide of 5 metres range, which would have complicated the currents, and added to the scouring action. Below Wâstah, the channel of the Nile Valley, contained between the Libyan and Arabian Hills, is much contracted. Under these conditions the floods from the Upper Nile would escape sideways through the depressions in the Libyan Hills into the Fayûm and the Wadi Raiân; into the latter by way of the Wadi Muellah, and possibly by other connections with the Nile Valley of a low enough level.

A large volume of water would thus be forced westwards out of the Nile Valley, and would find its way towards the sea to the west of Alexandria. In its endeavours to dig out a channel for itself it would erode laterally, or scour down vertically according as the softer material was found in one direction or the other. The different points of delivery and volumes of the water contributing to the flow, and the nature of the rock

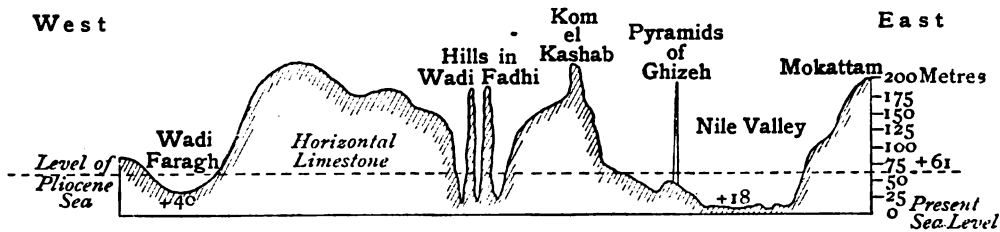
met with in its path would determine the form the channel would take at the various stages of its development. Tremendous eddies would be produced by projections of hard rock and contractions of the irregular channels, which would lift material from the bed and produce deep holes.

Had this action not been arrested by the further upheaval of the land, perhaps a second Nile Valley would have been formed branching from the main valley at Behnesa, passing through the Wadi Raiân and Fayûm depression, and continuing through the Wadis Fadhi and Faragh, west of Memphis and Cairo, to the Natron Lakes, and thence to the sea west of Alexandria; or returning to the Nile Valley, or side of what is now the Delta, but was then sea, at some point south of Alexandria.

If this theory is a sound one, the remarkable depressions of the Fayûm and Wadi Raiân are paralleled on a small scale by the deep holes (*bayarât*) scoured out below the bridges or cuts in the Upper Egypt Basin embankments, or outside a breach in a Nile bank.

The section, given on Plate XVIII., of 50 miles of the Nile Valley and desert opposite Cairo, is taken from Mr. Cope Whitehouse's article, entitled

PLATE XVIII.



SECTION OF 50 MILES ON LAT. 30°.

Borrowed from Cope Whitehouse.

Note.—The dotted line represents the level of the Pliocene Sea, but is not in Cope Whitehouse's section, which was drawn for another purpose.

"The Pyramid Hill of Gizeh," which appeared in the 'Quarterly' some time ago. It shows (assuming it on Mr. Whitehouse's authority to be a correct representation of the ground) the channels, that I have named, in the arrested state of development which they had reached, when the flow of water, which was digging them out, was cut off.

After the upheaval had raised their borders above sea-level, the sea would be henceforward excluded from the depressions and be replaced by the waters of the Nile, which would have entered by the gap in the Libyan

Hills at Lahûn. The upheaval continuing and the Nile at the same time scouring out its bed, a condition of levels would have come about, under which there would have been an annual inflow during the floods and outflow into the Nile on the floods subsiding.

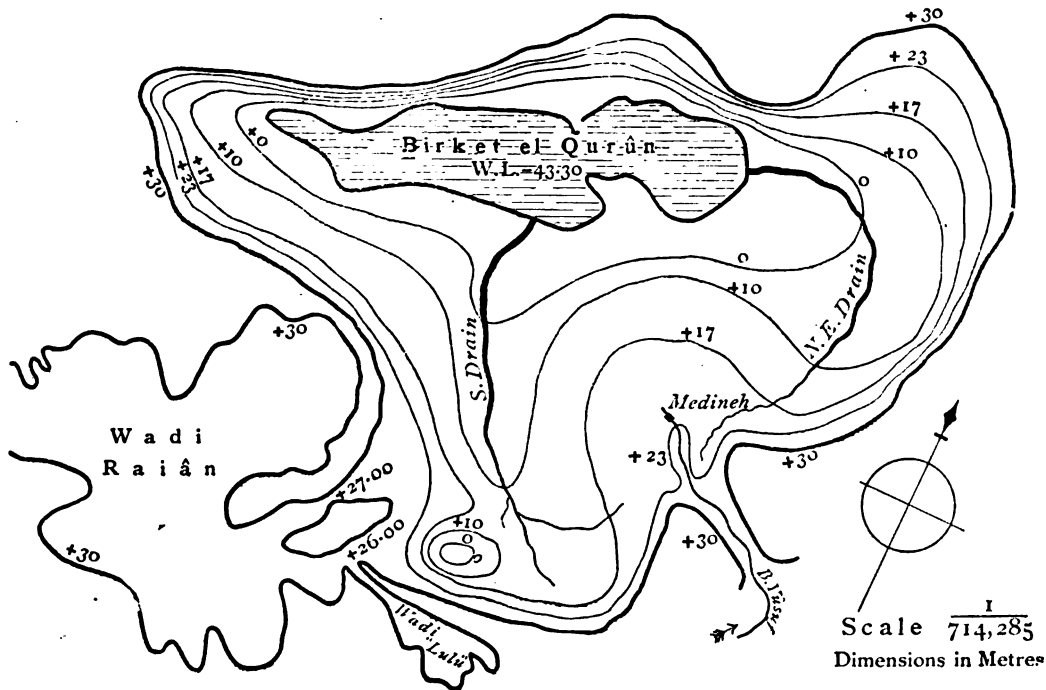
In a long series of years there would result a thick deposit of Nile mud in the Fayûm, the richest deposit being found near the point where the waters first spread themselves out after passing through the comparatively narrow defile in the Libyan Hills. The tendency of the entrance of the waters, heavily charged with silt, into an extended basin filled with water would be to form a delta of Nile deposit similar to that which the Nile itself has formed in entering the sea, modified by the form of the basin bed, which would not have been uniform like that of the sea. On account of the momentum of the body of water leaving the defile and entering the lake, there would be formed a projecting ridge (contour R.L. 23) of deposit in the direction of the flow, while the deposit, resulting from the end and side spills, would form in gentle slopes with approximately parallel and rounded contours (R.L. 17 to 10) on both sides, and at the end of the projecting ridge as shown in Plate XIX.

Thus, in consequence of the former action of rain on the surrounding hills, greater or less at different points along the borders according as the inclination of the adjacent watersheds was towards or away from the depression, and in consequence also of the deposition of Nile mud by the annual entry of the river flood, the bed of the lake formed in the depression would take the shape shown by the contours on the diagram of the Fayûm, Plate XIX. The former of these processes of change of the bed and borders of the depression may have ceased before the latter commenced to operate, or both may have acted simultaneously or alternately, which would account for layers of Nile mud being found near the Hawârah pyramid lying below the water-borne detritus of the hills.

From a knowledge of the rules which govern the formation of a Delta, and the consequent raising of the level of the river which forms it, we might conclude that the Nile floods in past times were not as high as they are now-a-days, though on the other hand we do not know that the floods were not greater in volume, and the probability is that they were. But whatever may be the truth about former Nile levels, the levels, at which Nile deposits are found in the Fayûm, furnish evidence of the maximum height to which the flood waters rose in the Lake.

At the commencement of the passage by which the waters entered the Fayûm, the highest Nile deposit is at R.L. 26·00. At Hawârah it is at R.L. 24·50, and along the ridge reaching out towards Medineh, R.L. 23·50. Probably, therefore, the water in the Lake reached about R.L. 26·50 at the commencement of the gorge, but the level of the Lake itself rarely, if ever, exceeded R.L. 25·00.

PLATE XIX.



CONTOURED DIAGRAM OF THE FAYÛM DEPRESSION.

Note.—This being a diagram only, all minor folds and indentations of contours have been suppressed, so as to show more clearly the general shape.

The upper contours along the north-west side of the Lake must not be considered to be accurately represented, as no surveys of this side have been made.

It will be as well to determine, before going further, whether the present volumes of the Nile flood would suffice to fill the Lake Fayûm to the level of R.L. 25·00, which I have assumed it must have reached to account for the Nile deposits on its borders at R.L. 24·50.

At the time we are considering, no artificial works existed for controlling the inflow and outflow of the Lake.

We have first to determine the lowest level to which the Lake would have been lowered by the outflow and evaporation at the end of the summer,

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and before the next rise of the river commenced. The Nile may have flowed at a lower level then (that is, in very early prehistoric times) than now, the summer volume was probably greater then than now, as the unbreached barriers in the upper reaches would have ponded up the water into reservoirs, which, slowly emptying themselves, would have helped to raise the summer level; the flow-out also from the Fayûm Lake would have raised at its exit the level of the summer Nile, at least during the winter months, but not necessarily during the summer months, as it may have expended itself sooner. There are thus three unknown elements in the problem, and nothing to witness to the former *minimum* levels in the same way that the Nile deposit does to the maximum levels. We are therefore forced to base the calculations on existing levels, and to suppose that the effect on the water surface of the former lower level of the Nile bed was counterbalanced by the increased volume of water flowing in the river bed. At any rate at some period sooner or later the present minimum level of the Nile must have been reached.

The probability is that the exit channel of the lake joined the Nile at or near Wâstah. Up to the end of April the rate of fall of the river exceeds the rate at which evaporation would lower a lake surface, but in May the river falls about 15 centimetres, and not at all on an average in June. Hence, up to the end of April the fall of the river would determine the rate of fall of the lake, but in May and June the fall due to evaporation would rule the rate.

The level of the Nile at Wâstah at the end of April may be taken to be ..	R.L. 18·75
The distance from Wâstah to Lahûn is	30 kilometres.
„ Lahûn to Hawârah	15 „
Total	45 „
Allowing a water surface slope for the outflow of $\frac{1}{25000}$, the difference in water surface level between the lake at Hawârah and the Nile at Wâstah would be	1·80
Hence the water surface of the lake at the end of April would be at ..	20·55
Evaporation would still further lower the surface in May by ..	·25
„ „ „ June „ ..	·80
	0·55
The water surface in the lake would thus become	20·00
Probably the commencement of the flow into the lake would not take place till a few days after the middle of July, which may be taken as the time when the lake reaches its lowest level for the year. Evaporation for this period of July must therefore also be allowed for, say	0·20
The lowest level of the lake would therefore be	19·80

The mean surface area of the Lake Fayûm between R.L. 19·80 and 25·00 may be taken as 2000 million square metres.

Evaporation during the ninety days of flood would tend to lower the level 70 centimetres.

The quantity of water required to raise the lake from R.L. 19·80 to 25·00 would therefore be $2,000,000,000 \times (5\cdot20 + 0\cdot70) = 11,800$ million cubic metres, or a daily average for ninety days of 131,111,111 cubic metres.

At the commencement of these ninety days the inflow would be small, increasing rapidly to the maximum ; and again, as the lake level rose and the Nile began to fall in October, the inflow would gradually decrease to nothing by the end of the ninety days. Hence it would probably be necessary to suppose a maximum daily discharge into the lake of about 200 million cubic metres a day for part of the time.

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Date.	Number of Years out of 16 in which the Supply given in Col. 3 would be available for abstraction.	Balance available after allowing for Lower Egypt.	Corresponding Gauge, Beni Suef.	Corresponding Gauge, Magnûnah Mouth on Nile.
		million cubic metres per day.	metres.	metres.
Sept. 1	11	67	28·08	26·64
„ 11	11	108	28·11	26·67
„ 21	11	162	28·14	26·70
Oct. 1	13	157	28·14	26·70
„ 11	12	174	28·15	26·71
„ 21	14	245	28·12	26·68
Nov. 1	15	372	28·05	26·61
„ 11	11	372	27·05	25·61
„ 21	11	67	26·40	24·98
Dec. 1	12	63	25·88	24·40

Colonel Western, in a note on the Wadi Raiân, shows that for a certain number of years out of sixteen years (1872 to 1887, of which he had the statistics to work with) there is a surplus discharge in the Nile which might be abstracted without in any way interfering with the ordinary irrigation of

the Delta. In his calculations he takes 565 million cubic metres in twenty-four hours as the discharge required by the Delta during September and the first half of October. He is, of course, referring to the conditions of the Delta at the present time. He gives the table which appears on the preceding page, to which I have added the corresponding gauge levels at Beni Suef and Magnûnah mouth for reference further on.

The month of August has not been given, as the conclusion was come to that there was no water to spare in August under present conditions.

The calculation, giving these figures, is made assuming that regulation on the Barrage below Cairo is not called in to assist; the discharges allowed to Lower Egypt, after abstracting the above quantities, being sufficient to give a water surface at the level required for irrigation without any heading-up. Now, the quantity required to fill the lake to R.L. 25·00, as found before, is 11,800 million cubic metres. This, let us suppose, would be made up thus:—

September	30 days at 112 millions	= 3,360 millions.
October	31 „ 192 „	= 5,952 „
Parts of August and November ..	29 „ 86 „	= 2,494 „
	Total ..	11,806 „

These discharges could be abstracted without affecting Lower Egypt irrigation, as it exists now, for eleven years out of sixteen. This, however, is not a quite correct statement as applied to each of the eleven years, since the discharges given in the table are the *averages* of those years in which a surplus discharge is available. Among these would be some very high years, in which it would be possible to fill the lake to a higher level than 25·00, and years when this level would not be reached.

Besides the years, for which the averages of surplus discharges are taken, there would be five years out of sixteen when the supply would fall short in September, the month of highest level.

There is no necessity in this stage to seek for a connection between the lake and the Nile for filling the lake, as the water would find its way in large volumes across all the low parts of the valley into the drainage depression along the edge of the Libyan Desert, now known as the Bahr Yûsuf.

The levels at which the Nile deposits are found in the Fayûm, the discharges which might be drawn off from the Nile, and the area of the

Fayûm Lake are thus all in agreement with the supposition that the level of the Fayûm lake was yearly raised from about R.L. 20·00 to 25·00, and that the level attained was never sufficiently high to cause an overflow into the Wadi Raiân.

THE FAYÛM AS LAKE MÖERIS.

Judging then from the evidence furnished by Nile deposit and fresh-water shells, there is nothing to support the theory that there has been any *great* change in the Nile levels since the waters first found their way into the Fayûm. But whatever conditions of levels and volumes of Nile discharges we start with, we must at some date arrive at the period of present conditions. According to Mr. Petrie, however, there is good evidence (which I will give later on) to support the theory that in Herodotus' time the Nile levels were 2 metres lower than now, and it is further probable that, at the time of the transformation of the Lake Fayûm into Lake Mœris, the Nile volumes were what they are now. I shall, however, discuss the subject, assuming that present conditions as to Nile levels also existed at the formation of Lake Mœris, and point out afterwards how the difference of 2 metres in the level at the time of Herodotus affects the conclusions.

The formation of Lake Mœris is credited to Amenemhat III. of the XIIth Dynasty, who gained a reputation for making great improvements in the Irrigation Department, and carrying out hydraulic works of immense benefit to the country, about 2500 B.C., or within 5000 years of to-day. Now, 5000 years, geologically estimated, is a very short time, and we may assume, without much chance of error, that he had practically the same *general* conditions to work with as regards *relative* levels of land and water and Nile discharges as we have to-day.

The Fayûm Lake would, in his time, have filled and emptied itself, and low Niles would now and then have occurred. But even without the occurrence of a low Nile it would have been observed that during the summer, when the surface of the lake in the Fayûm had reached its lowest level, there was a considerable area of land, formed of Nile deposit, laid bare. A shining light among the king's subjects may have conceived a project for reclaiming this land from the annual inundation, submitted his project to the king and obtained his approval to its execution.

The problem would be that, while reclaiming the land, the advantages to be derived from a natural regulator to the Nile should not be lost. The return flow which took place from the lake would, while it was uncontrolled by artificial works, be greatest when there was least benefit to be derived from a raising of the Nile water-surface; and least in the summer months, when an addition to the Nile discharge would have been most needed. The effect of the uncontrolled early return-flow might even have acted disadvantageously in checking the fall of the Nile level in December and the following winter months, and thereby delaying the draining of the lands which had been inundated by the preceding flood.

Now, although the amount of water stored in the lake might, according to the project we are considering, become less in quantity than it was before control was introduced, still by husbanding the water till the season of low Nile, when an addition to the Nile was most required, the same benefits might be obtained from the reservoir during the summer months as were felt when the lake acted under nature's guidance only; and in addition to this, the flood water would be more quickly drained off the inundated lands, and crops be sown earlier, than would have been the case when the return-flow from the lake commenced with the fall of the Nile.

The project would then consist of works for admitting water into the lake until it rose to a certain height and then excluding any more, with the exception of about 10 to 15 million cubic metres a day, which would be required to make good the loss by evaporation over an area of about 1500 million square metres. The same work could be adapted to hold in the water on the fall of the river, and let it flow back when required; or this duty might be performed by a separate regulator. Some point between Lahûn and Hawârah would be chosen to make a bank and regulator to bar the Bahr Yûsuf passage through the hills. Probably a convenient place was found near Hawârah pyramid, close to which the Labyrinth was built.

By limiting the level of the lake to R.L. 22·50, all the area above that level, which is that of the highest plateau in the Fayûm, would be left uncovered, and fitted for cultivation and habitations.

The regulator established and the level of the water in the lake being thereby brought under control, it would be safe to commence the occupation of the reclaimed land.

All this is speculation as to how the natural Fayûm Lake became transformed into the artificially controlled Lake Mœris of Herodotus. There is

little to base speculation upon, and therefore the transformation process may be varied within certain limits at the choice of the speculator.

Mr. Petrie's views, already given at length, suggest a modification of the foregoing, which I will give as an alternative idea.

The natural drainage channel for carrying off the overflow of the Nile, now the Bahr Yûsuf, being situate in the lowest lying lands, would of necessity be kept clear by the annual discharge of the waters from the inundated lands. On reaching the south end of the isolated piece of desert in front of Lahûn, part of its discharge would go east of this island, part to the west. The western discharge would, at Lahûn, either enter the Fayûm, or part would do so and part continue northwards. At the north end of the isolated piece of desert, the discharge, going northwards, would again divide up, some of it continuing to flow in the channel under the Libyan Desert, some finding its way back to the Nile near Wâstah. Under these circumstances the channel north of Lahûn would not be so likely to keep itself clear as the channel to the south of Lahûn. Thus the channel conducting the water to the Fayûm would remain clear, while that carrying the outflow would be less likely to do so. The outflow would also be more within soil (i. e. below the land surface) than the inflow and therefore under worse conditions for keeping its channel open. The outflow channel might therefore deteriorate, and, as there would be water flowing in it during the hot season at a low velocity, reeds might grow and obstruct the water-way. The draining of the Fayûm Lake would therefore be unsatisfactorily done, and the water would stand in it at a comparatively high level till the end of the summer. This would encourage the growth of rushes also in the Lahûn-Hawârah passage, which would check the inflow, and, while preventing the rise of the lake, would favour silt deposit. "This then," in Mr. Petrie's words, "was the state in which the great engineering monarchs found the province:—a basin full of overflow Nile water, replenished at each inundation through a marshy shallow inlet and with much of its bottom so raised by deposits as to have become almost marsh ground, like the present lakes about the coast."

A channel to drain off the water at low Nile and reclaim the marshes would have been the first work to suggest itself, and the necessity for regulators, to prevent any excess of water from entering by the cleared channel, would then have been felt. The flow of water in the drain leading back to the Nile may have suggested the grand idea of utilising the lake as a regulator for the excesses and shortcomings of the Nile.

Amenemhat I., who was a sportsman, and prided himself on "hunting the lion and bringing back the crocodile a prisoner," may have chosen the point which projected farthest into the Lake (now Medinet-el-Fayûm and Kom-Faris) for the site of his palace and garden. Here he would escape from the pestilential odours that he probably kept about him in his original home, and at the same time enjoy the desert air, cooled by the immense surface of the lake, on which he could indulge his taste for crocodile hunting. The natural attractions which so rare a combination of desert air and open space of water would afford, would probably, under the royal favour, have made the new watering place and sanatorium a fashionable resort for the aristocracy, who would soon have built villas on the borders of the lake along the esplanade of Crocodilopolis, or Shed, as its first name appears to have been.

The modern Helouan, a dry treeless spot on the eastern desert a few miles south of Cairo, found favour in the eyes of the late Khedive, Tewfik Pasha, and became a sanatorium for the Cairenes, to whom a good draught of pure desert air must be a real treat after living in the tainted air of Egypt's unsavoury capital. Helouan has sulphur springs to boast of, but Crocodilopolis had a fine expanse of sweet water to look out upon, instead of a dry, blinding and scorching desert.

The area above R.L. 22·50, at first reclaimed from the lake between Lahûn and Medineh, would have been about 10,000 acres; and the king and his favourites would, according to nature, have taken possession of it. But there would have been an extensive shore of habitable ground round the margins of the lake and on each side of the canal connecting the lake with the Nile, which would be within reach of a perpetual water supply and with the means of water transport at the door almost of the habitations.

When the attractions of Crocodilopolis and its suburbs became more appreciated and the population increased, the want of a larger area of cultivable land would be felt. There would also be another inconvenience, besides scarcity of arable land, felt by the dwellers in Crocodilopolis, arising from the yearly fall of the water surface. At high water, when the lake was filled up to R.L. 22·50, embarkation and disembarkation from boats might take place at Crocodilopolis itself, but, as the waters of the lake were allowed to flow back to the Nile, and the water level fell to R.L. 20·00 or 19·50, there would be laid bare a muddy margin of 2 kilometres breadth between the city and the water, which could with difficulty be crossed, and if crossed, the

depth of water along the edge of the lake would be found too shallow to allow boats to get close to the land. One or both of these wants probably was the cause that led to the construction of the bank from the high land,

PLATE XX.

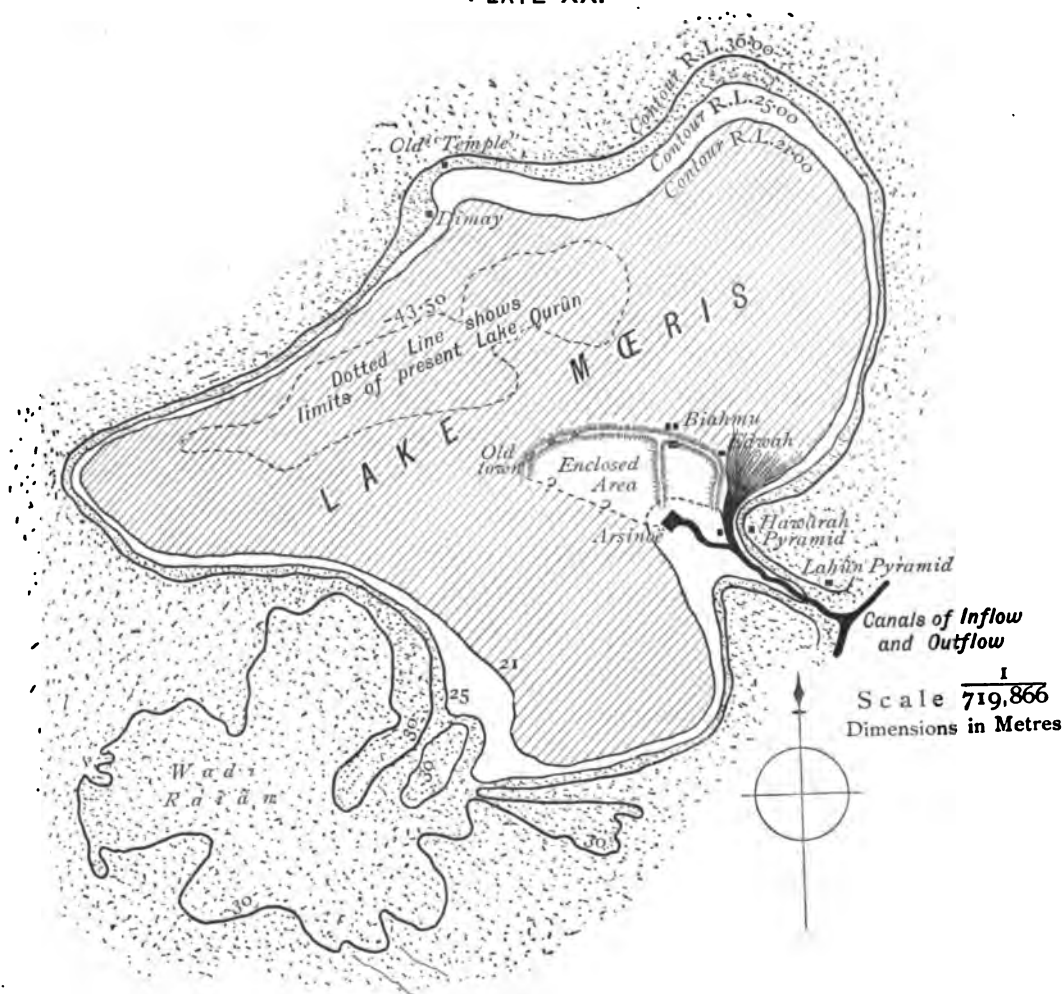


DIAGRAM SHOWING THE LIMITS OF LAKE MÆRIS ACCORDING TO THE THEORY FAVOURED IN THIS PAPER.

Note.—The contours along the N.W. side of the lake are not accurately shown as this side has not been surveyed. Outside the contour of R.L. 25.00 the dotted surface represents uncultivated desert. Within the contour of R.L. 21.00 the area crossed by parallel lines represents the water-surface of Lake Mæris. The unshaded and undotted area represents the cultivable land in and around Lake Mæris.

east of Edwah to Biahmu, and thence, it appears probable, to Medineh. (See Plate XX.) The bank from Edwah to Biahmu runs generally along contour

L

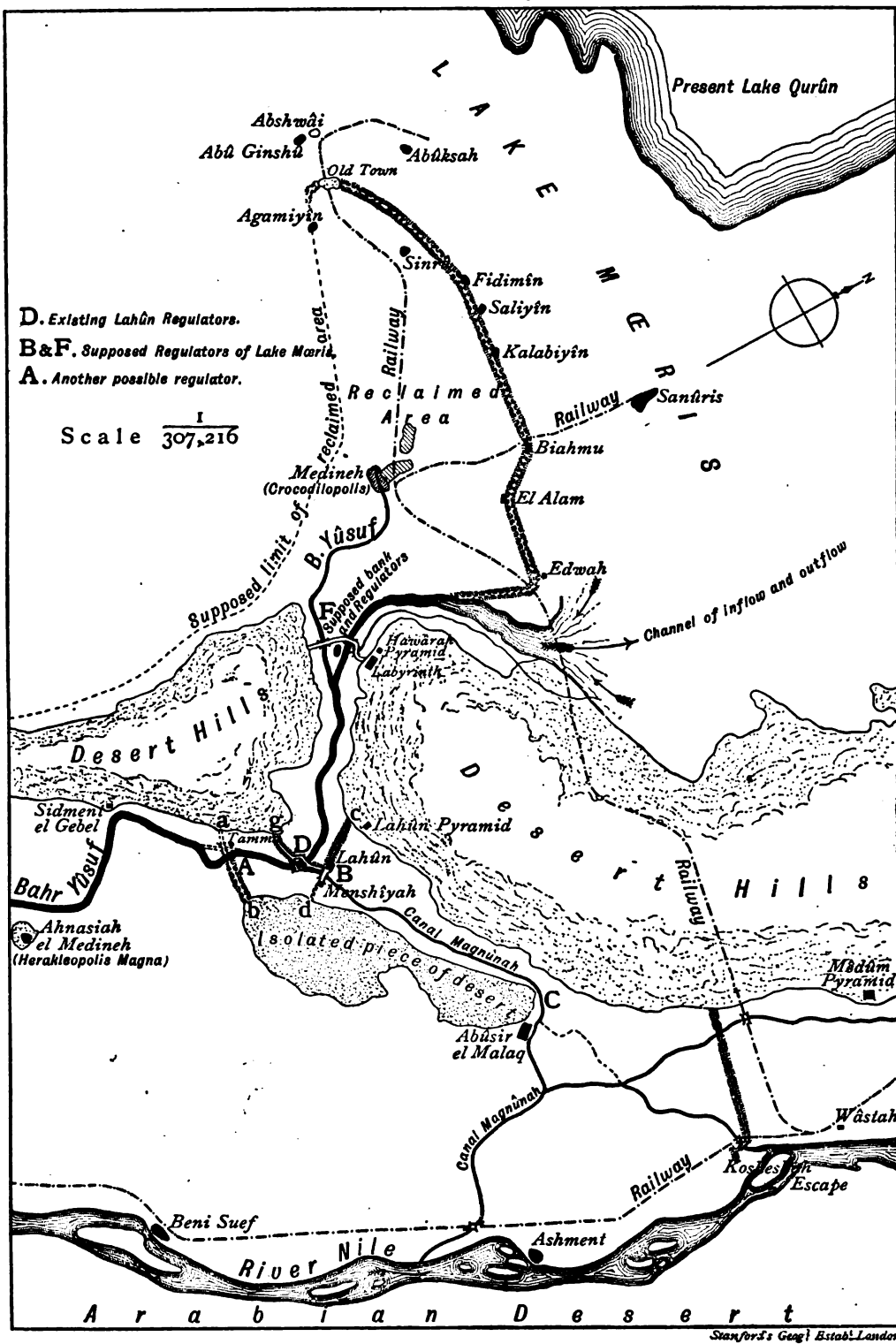
R.L. 17·50, and therefore would have been formed in water, probably with material transported from the high lands on the east and south-east of Edwah. This may account for the material of which the bank is formed being different from the land on either side of it, and for the absence of any trace of a borrow pit from which the bank was made. Such a bank, connected with the high land east of Edwah, running along contour R.L. 17·50 and joined from Biahmu to the high land at Crocodilopolis, would have enclosed an area, from which the lake water would have been excluded, the other two sides of the enclosure being formed by the natural ridge at the end of which Crocodilopolis was built, and by the high land connecting this ridge near Hawârat-el-Maqta with the commencement of the artificial bank at Edwah. From the levels of the rock underlying the Nile deposit at Hawârah it seems probable that the entering waters flowed in greatest volume past the Hawârah pyramid, separating the reclaimed tract from the desert on which the pyramid stands. Possibly this was the only channel by which the waters were admitted to the lake, and across which the regulator was built in the immediate neighbourhood of the Labyrinth and pyramid. The present course of the Bahr Yûsuf beyond Hawârah may have been closed and the Medineh ridge connected with the high desert on the left of the Bahr Yûsuf, near the modern head of the Gharaq canal. At present it is so connected, and the connection is only broken by artificial canals cut through it.

Thus would the second reclamation have been contrived, and it would have added about 7000 feddans of good land to the 10,000 feddans included in the first reclamation.

The Edwah bank, however, does not stop at Biahmu, but (a fact Linant did not remark) continues in its first alignment to Kalabiîn, past Saliîn and Fidimiîn, to a point a little to the north of Sinrû. (See Plate XXI.) Thence it curves round towards the south, and crosses the Abûksah Railway at a point half-way between Agamiîn and Abshiwâi (Abû Ginshû). At this crossing are extensive remains of an old town on the line of the bank. The remains of several smaller towns are also to be found between the railway and the point in the bank north of Sinrû, all on the line of the bank. From this length of bank other banks at different angles to the main bank seem to have existed; some appeared to go towards Medineh, others towards Abûksah in the direction of Lake Qurûn.

Following the main bank on the other side of the railway along contour R.L. 17·50 or thereabouts, a ravine is crossed, on the far edge of which, in

PLATE XXI.



MAP TO SHOW POSITION OF SUPPOSED REGULATORS OF LAKE MÆRIS.

the line of the bank, is a peculiar black mound, formed of layers of cinders or some material that has been blackened by fire. The bank is thence traceable for about a thousand metres more, continuing in a due southerly direction, and then it is lost among the thick plantations of date-trees which commence at this point and extend to Tobhâr.

Does it double back to Medineh through Talat and Sinbat; or continue along its contour through Tobhâr, Manâshi, Disyâ, Abgig, and to the desert near Azab? (See Map at end.) There were found no traces to show. A further examination of the ground on both sides of the Abûksah Railway has thrown no light on the matter. It would appear that the traces of the bank end somewhere in the triangle formed by joining the villages of Abû Ginshû, Agamiîn, and Sinrû.

I thought it might be possible that, either from near Sinrû or west of Agamiîn, the bank was carried up the slope, at right angles to the contours, to Medineh to close the side of the new area to be reclaimed, but I looked for its traces in vain. But, *supposing* the existence of this side-bank, the new area, enclosed by the bank joining Medineh, Sinrû (or Agamiîn), and Biahmu, and bounded also by the former bank from Biahmu to Medineh, would add about 10,000 feddans to that already reclaimed, bringing up the total to 27,000 feddans.

The want of a larger cultivable area would thus by these reclamations be partly met.

Now, as the artificial bank was formed along contour R.L. 17·50 (under the conditions assumed), and the water of the lake, as will be shown afterwards, never fell below R.L. 19·50, there would at lowest water be 2 metres depth of water up against the bank, and the most convenient point of embarkation and disembarkation for the inhabitants of Crocodilopolis on their way to Memphis would be at Biahmu, which they would reach by the road running along the top of the artificial bank formed between Crocodilopolis and Biahmu. They would take ship at Biahmu for the north-east corner of the lake, whence the desert route runs direct to Memphis. This is the direct road used to-day by the natives, who journey between Medineh (Crocodilopolis) and Bedreshên (Memphis), the road passing through Tamtyah, the site of which was, at the time that we are considering, 30 metres below water. (See Map at end.) It was therefore strictly correct to say that Lake Mœris lay between the Memphite and Arsinoite Nomes.

The ruins at Biahmu, of which Plate XXII. shows the present condition,

PLATE XXII.



Ground level on which
erect figure stands.
R.L. 18.02.

Top of corner stone
R.L. 21.59.

C.L. outside enclosure
in wheat field
R.L. 17.05.

BIAHMU RUINS.

are not in the line of the main bank from Edwah to Kalabiin, but about 300 metres to the north of it. It is probable, therefore, that they were placed at the end of a projecting bank, in connection with the main bank, alongside which boats could lie. The two colossal figures (Plate XXIV.) mounted on their pedestals would have formed splendid landmarks for ships crossing from the north shore of the lake.

Thus we have a vast lake of about 1600 million square metres of water surface, and an area of 27,000 feddans (acres) reclaimed from it, with Crocodilopolis in the reclaimed area, and the Hawârah pyramid and the Labyrinth on the shores of the lake at the point where the waters entering the lake were controlled. (Plates XX. and XXI.) This, I believe, was the Lake Mœris of Herodotus and of those who confirmed his testimony, and Mr. Petrie, as I have shown before, holds the same general views.

But his theory, that the two pyramids, which Herodotus stated stood about the middle of the lake, were identical with the two colossi of Biahmu, of which the present ruins are all that is left, does not appear to me a satisfactory explanation of the account of them given by Herodotus, though to what Herodotus said he was *told* I think no importance need be attached, as statements in a foreign language are apt to be misunderstood or misinterpreted. Arab traditions also may be curious and interesting, but they are of little value as a record of the past.

It will be worth while to calculate the inflow and outflow of the lake in the condition, in which I have supposed it to be, as Lake Mœris, and to see if the existing features of the Nile Valley throw any light on the statements of the first historical witnesses to its existence.

In my former calculations of the volumes of water required to fill the Fayûm depression to higher levels, I have taken the area of the depression at 2000 million square metres. But our mean water level is now R.L. 21·00, and the area of the lake will be reduced.

The present taxed area in the Fayûm is nearly	234,000 feddans.*
The actual cultivated area is more probably about	280,000 ..
The area of the Birket-el-Qurûn is about	70,000 ..
Total	350,000 ..

* A feddan = 4200 square metres.

350,000 feddans	=	1,470,000,000 square metres.
Add the uncultivated area below R.L. 21·00 ..	=	300,000,000
Total ..		1,770,000,000
Deduct areas reclaimed from Lake Möeris:—		
1st reclamation	40,000,000	
2nd „	24,000,000	
3rd „	40,000,000	
		104,000,000
Remaining for area of Lake Möeris		1,666,000,000
		or, say, 1600 million square metres.

Now let us suppose that the exit channel joins the Nile at the point where Kosheshah Escape has been built, a little above Wâstah (Plate XXI.)

The lowest summer levels at Wâstah were in 1887, 18·82; 1888, 18·12; 1889, 18·26.

Let us then call the mean L.W.L. of Wâstah 18·50.

As the exit channel would be of considerable dimensions, we may suppose a water-surface slope, at the *final* date of outflow, of $\frac{1}{50,000}$. The distance from Wâstah to Lahûn is 25 kilometres, and from Lahûn to Hawârah 10 kilometres; total 35 kilometres. The fall in this distance would then be 0·70, which would make the level at Hawârah, or the level of the lake ($18·50 + 0·70 =$) 19·20. But the outflow, even at the date of the lowest level of the Nile, before the rise commenced, may be assumed to have raised the Nile 30 centimetres, which would make the lowest level of the lake R.L. 19·50.

The water surface of Lake Möeris would therefore oscillate between the level of 22·50, beyond which the regulator would be used to prevent its rising, and R.L. 19·50, below which it could not fall on account of the level which the Nile maintains at its point of union with it.

On the map of Linant Pasha's, published in 1854, before the railway and Ibrahimîyah Canal were made, the channels in the Nile Valley shown in connection with the Lahûn entrance are the Bahr Yûsuf, coming from the south, and the Magnûnah Canal going north. The latter, after going north for 13 kilometres, is joined by three channels, the first taking off from the Nile at Beni Suef, and the second and third a little south of Ashment. The third is the old Magnûnah. These channels unite in the neighbourhood of Abûsir-el-Malaq, the second passing by the village of Bûsh, the immense heap, on which the modern village stands, witnessing to the existence of an ancient town on that spot. Abûsir-el-Malaq also was evidently in the far past a place of importance. North of Abûsir-el-Malaq the channel of the

Magnûnah is continued as a single channel along the west desert for 4 or 5 kilometres when it bifurcates, one branch continuing under the western desert, and the second going east to join the Nile at the point where Kosheshah Escape now stands. Some of these channels are shown on Plate XXI.

Having evidence of no other channels, let us suppose that the Magnûnah Canal with its mouth near Ashment was the feeder, the branch to Kosheshah Escape the exit channel, and the eastern branch under the western desert a canal of supply to Memphis. (The Bahr Yûsuf I do not consider as in those times a channel in *direct* communication with the Nile.)

With R.L. 22·50 and 19·50 as the maximum and minimum levels of Lake Moëris, there would, under these circumstances and unless prevented by the use of a regulator, have been a flow into the lake from about the 15th July to the 15th January, and a return flow from the 15th January to the 15th July.

The levels of the Nile and lake would have been approximately as follows :—

		R.L.
Lowest water levels, when lake ceases to flow out and the flow-in is about to commence.	Lake	19·50
	Junction at Abûsir-el-Malaq	19·40
	Magnûnah Nile mouth at Ashment ..	20·00
	Outlet into Nile at Kosheshah Escape	19·00
Water levels on 15th January, when flow-in would cease and lake return-flow would commence.	Lake	22·50
	Abûsir-el-Malaq	22·00
	Magnûnah mouth	23·00
	Outlet, Kosheshah	21·00
Ordinary flood maximum levels at end of September.	Lake	21·50 to 22·50
	Abûsir-el-Malaq	25·30 to 27·40
	Magnûnah mouth	26·00 to 28·00
	Outlet, Kosheshah	24·80 to 27·00

The year 1888 was one of very low Nile flood, but even in that year, from about 20th July to 15th November, the Nile level at Magnûnah mouth was above R.L. 23·00, and reached R.L. 26·00 at the top of the flood.

The quantity of water required to fill the lake from R.L. 19·50 to 22·50, and to allow for its evaporation for six months, is calculated as follows :—

	Million cubic metres.
Volume required to raise lake 3 metres = 1600 million square metres $\times$ 3 ..	4800
Volume required to make good 6 months' evaporation = 1600 million square metres $\times$ 1·30	2080
Volume required for irrigation of 25,000 feddans reclaimed, for 6 months ..	100
Total volume required ..	7580

The greater part of this would be poured in during the three months of flood, say 5000 million cubic metres in 100 days, or an average of 50 million cubic metres a day.

There now remains to be calculated the discharge that this reservoir would give back to the Nile during the low water months.

	Million cubic metres.
The content of the stratum of water between R.L. 22·50 and 19·50 is 1600 million square metres × 3	4800
Of this there would be lost by evaporation during the 6 months 1600 million square metres × 1	1600
There would thus remain available for purposes of irrigation	3200
The reclaimed land round Arsinoë (about 25,000 feddans) would require about 50 million cubic metres for its irrigation during the 6 months of winter and summer	50
The balance available for the Nile Valley would be	3150

If we suppose this water husbanded and made use of only during the 100 days of summer, when its want is most felt, the lake would give an average daily discharge to the Nile of $31\frac{1}{2}$ million cubic metres, that is, the low Nile discharges would be doubled and raised from 30 millions to 60 millions. But by a careful distribution of this stored-up water between the months of April, May, and June, and ten days of July, it would have been possible to keep up the discharges constantly to seventy millions, as shown in the table below :—

Month.	Average Nile Discharge, without reservoir.	Supplied by reservoir.	Total Increased Discharge.
March	70,000,000	Nil	70,000,000
April	45,000,000	25,000,000	70,000,000
May	34,000,000	36,000,000	70,000,000
June	34,000,000	36,000,000	70,000,000
July 1 to 8 ..	45,000,000	25,000,000	70,000,000

The supply from the reservoir will thus be
 $(36 \text{ million} \times 61 \text{ days}) + (25 \text{ million} \times 38 \text{ days}) = 3146 \text{ million cubic metres.}$

Such an increase of the summer supply would probably have the effect of doubling the area under summer crops in the Delta, if it could be obtained

now, but it is not clear how it could have been utilised without a barrage to raise the water-level, and without, as far as we know, any Sêfi (summer) canals.

It is not, however, imagined that in the days of Lake Mœris there was any such scientifically economical control of the Nile waters, as supposed in the foregoing calculations, but they are given to show what the *possibilities* of a lake under the conditions assumed would be. My aim has been to establish its utility, in answer to Linant's argument against the developed Lake Qurûn theory, which consisted in a demonstration that this lake could have served no useful purpose, such as the historians credited it with.

Possibly the needs of navigation were a more important consideration in those days than summer irrigation, though not given the first place now. An increased volume supplied at low water to the shallowing water-routes would even for this object have been a gain.

The disappearance of all trace of the regulators is felt by some to be a difficulty in the way of the admission of their former existence, inasmuch as the ancients built on such a colossal scale. But the Labyrinth, which was built out of the reach of water, has disappeared, and its traces were only of late years identified in a mass of stone chips and trenches filled with sand, which underlay the foundations. Such being the fate of the Labyrinth, which must have surpassed the regulators as a structure of colossal dimensions, it is only natural to suppose that the stones forming the superstructure of the regulators should also have been removed for the same objects as the stones of the Labyrinth, and, if the materials of the floors were spared, it would only be on account of their situation being unfavourable to their removal. But, if spared, the action of running water would in time cause their disappearance, either by undermining them and burying them to depths below their original position, or by depositing a layer of mud above them. In the latter case they may still exist in a situation where some future excavation may chance to bring them to light again.

Hence I hold that, in the face of Strabo's explicit statement that there were regulators at each end of the canal for controlling the inflow and out-flow of the lake, the objection of want of evidence of the former existence of regulators is not sufficiently strong to be allowed to have much weight against the theory, that the submerged Fayûm, with the entry and exit of its waters kept under control by regulators, and its water-levels ranging between R.L. 22·50 and 19·50, was the Lake Mœris of Herodotus; the

M

Arsinoïte Nome, in connection with it, consisting of the reclaimed high lands within the limits of the lake and along the borders of the lake itself and margins of the feeder canal. It is admitted, as a weak point in this theory, that unless the Arsinoïte Nome can be imagined as extending into the Nile Valley, the area of cultivable land comprised in the nome is very limited. Let us see how far such a conception of Lake Moëris is in accord with the testimony of the ancient records which relate to it.

Strabo remarks, that "the Lake Moëris, by its magnitude and depth, is able to receive the superabundance of water which flows into it at the time of the rise of the river, without overflowing the inhabited and cultivated parts of the province." This could not be made to accord with M. Linant's theory, and can only be understood by supposing that the *high* lands in the Fayûm were reclaimed, and that the flood waters filled the rest of the Fayûm without rising so high as to inundate them. At the same time the area of the lake must have been great to fit it, under this limitation, to receive a sufficient volume to moderate the Nile floods and to be able to return to the Nile a sufficiently large supply to supplement the low Nile discharge in an efficient manner. The figures representing the possible performances of the lake have been given.

Diodorus also says, "Accordingly the king dug a canal from the Nile to the basin 10 miles in length and 300 feet in breadth." This would seem to show that the canal took off from the Nile immediately opposite Lahûn, for, if its mouth had been carried further south up the Nile, its length would have exceeded 10 miles. The breadth of 300 feet equals $91\frac{1}{2}$ metres. This also agrees with the size of the inflow and outflow canals which would have been necessary to discharge the calculated volumes.

A canal with bed width 90 metres, depth 8 metres, and water surface slope $\frac{1}{20000}$, will discharge about $69\frac{1}{2}$ million cubic metres per 24 hours, which agrees with the calculation for the inflow.

A canal with bed width of 90 metres, depth $6\frac{1}{2}$ metres, and water surface slope of $\frac{1}{25000}$, would discharge 34 million cubic metres per 24 hours, which agrees with the calculations for the outflow.

Diodorus remarks also that "a little south of Memphis a canal was cut for a lake, brought down in length from the city 40 miles." This is somewhat obscure, but may mean that a canal 40 miles in length was dug to connect Memphis with the lake. Supposing the canal that fed the lake from the Nile passed Abûsir-el-Malaq as already described, the canal to connect

the lake and Memphis would have taken off from the feeder canal at or near Abûsir-el-Malaq. The distance from that point to the modern Bedreshên, the station at which tourists alight for viewing the ruins of Memphis, is 47 miles, and it is quite possible that what was known as Memphis extended several miles to the south, and that the canal was only 40 miles in length between Abûsir-el-Malaq and Memphis.

Herodotus states that the lake is six months filling and six months emptying. With the surface level of the lake limited to R.L. 22·50, and with the mouth of the feeder canal near Ashment and the outflow at Koshe-shah Escape, such would be the case, for though the lake might be filled during the months of flood to R.L. 22·50, there would still be a flow into the lake for the remainder of the six months to meet loss by evaporation.

On the shores of the Lake Moëris would stand the Labyrinth with its pyramid (Hawârah), and within the lake area Crocodilopolis or Arsinoë (Medinet-el-Fayûm). The lake would serve as a moderator for the Nile in flood, and would supplement the short supply of the river in summer. It would have had a perimeter of 220 kilometres against Herodotus' perimeter of 360 kilometres, assuming that Jomard and others were right in supposing that Herodotus made use of the little stadius. The greatest depth of the lake, when filled to R.L. 22·50, would have been at least 70 metres against Herodotus' depth of 92 metres.

The lake itself was not artificially made, as supposed by Herodotus, but was brought under control by the works of man.

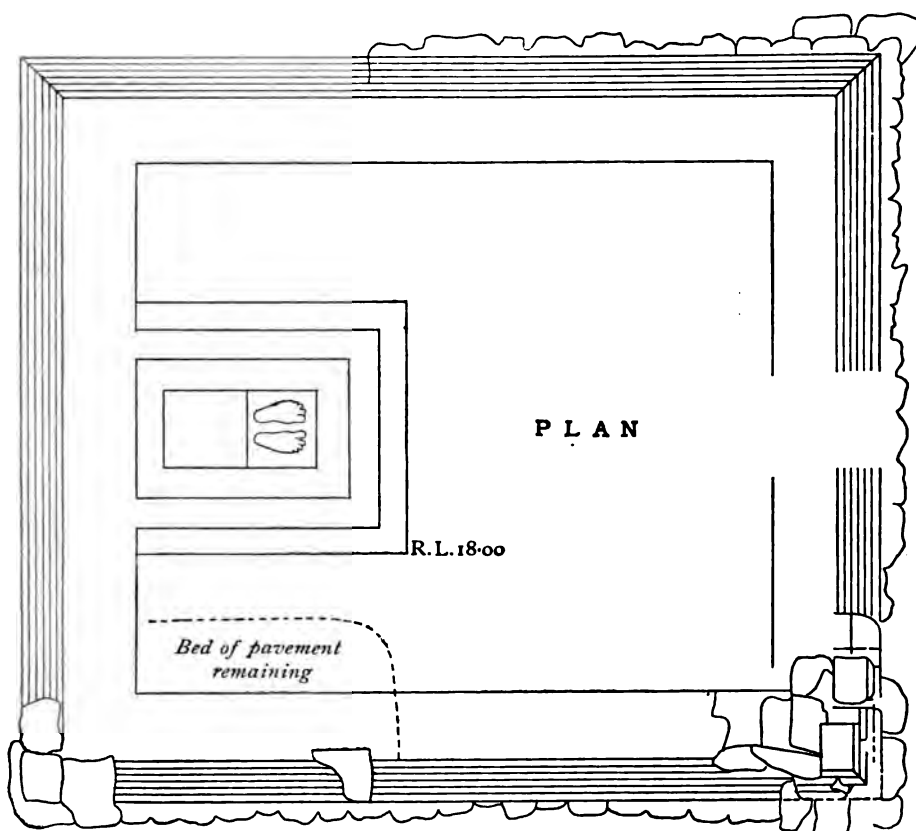
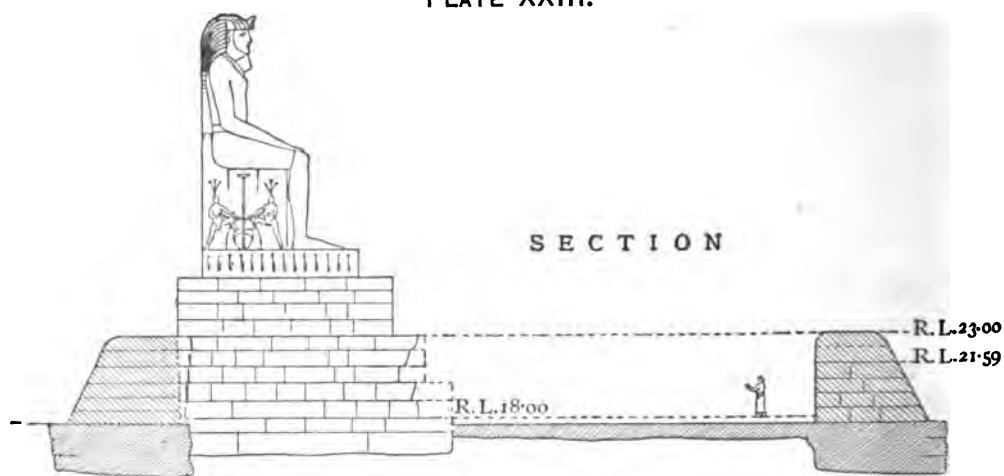
The water in the lake came from the Nile and not from local sources.

The lake lay between the Arsinoite and Memphite Nomes.

Herodotus and others after him state that there existed two pyramids, crowned by colossal statues, centrally situated in the lake, and Herodotus thus describes them:—"The lake lies oblong north and south, being, in its deepest part, 50 fathoms deep. It tells its own story that it is artificially made, for about the middle of the lake stand two pyramids, each rising above the surface of the water 50 fathoms, and that part of them which is built under water being as much more. On the top of each (or *against* each, according to Cope Whitehouse's translating) is a colossal figure seated on a throne. So these pyramids are 100 fathoms high."

It is supposed by some that the ruins at Biahmu (Plate XXII.) are the remains of what Herodotus described as pyramids. Possibly they are, but it seems a somewhat feebly supported supposition. Though a colossus on the

PLATE XXIII.



Scale $\frac{1}{350}$
Dimensions in Metres

RESTORATION OF A COLOSSUS, BIAHMU, FAYÛM.
Reproduced from Petrie's 'Hawara, Biahmu, and Arsinoë.'

top of a pyramid is not what one would expect to find there, and the dimensions of the pyramids given by Herodotus are, of course, obtained second-hand and may be worthy of little reliance, still the evidence, that the Biahmu ruins are the remains of what he referred to, does not seem to me convincing.

Mr. Flinders Petrie considers that these ruins are the remains of what was once a place of embarkation and disembarkation on the lake, consisting of a flight of steps, flanked by two colossi raised on high pedestals. In one of his publications he has pictorially reproduced these colossi, their pedestals and enclosure walls, in a most complete manner (Plate XXIII.), his only personal acquaintance with the figures consisting of a broken nose and fragments of stone drapery, discovered among the débris of their ruins. To one of the uninitiated, even after studying the evidence adduced by Mr. Petrie, there appears to be a great deal of esoteric ingenuity or imagination in the process of reproduction, but one or the other of these gifts is a necessity in dealing with anything Egyptological on account of the incompleteness of the historical records. Plate XXIII. gives a reproduction of Mr. Petrie's restoration, and Plate XXII. is from a photograph of the ruins as they exist now. The reduced levels have been added by me.

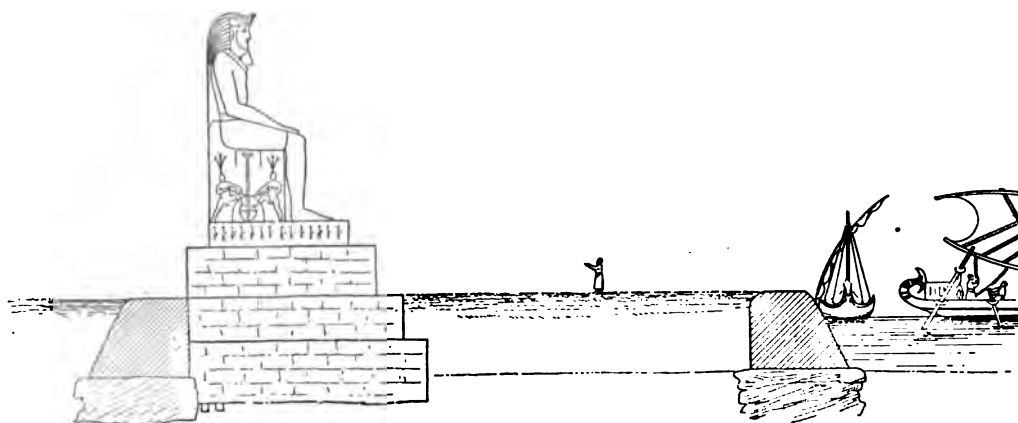
In Mr. Petrie's restoration he has shown the worshipper down below, standing on the general country level. My idea is that the interior of the courtyard was filled up to the level of the surrounding wall and formed a landing-place, as I have indicated in Plate XXIV. by the upper figure and the boats. If the water stood up against the courtyard wall, as I have shown, since there is no mortar in the joints of the masonry, the man below (as shown in Mr. Petrie's unmodified representation) would have been drowned out.

This landing-place was probably connected at the back by a bank with the main bank running through Biahmu.

It appears that some say that the lake waters flowed into and out of the lake by one and the same channel, and that others say there were two canals, one for the inflow and another for the outflow. These two accounts may be reconciled by supposing that the former referred to the canal south of Abûsir-el-Malaq, which is a single canal, Plate XXI., and that the latter referred to the channels, one of which was for the inflow from the Nile near Ashment, to Abûsir-el-Malaq; and the other for the outflow from Abûsir-el-

Malaq to Memphis or perhaps to the point on the Nile where Kosheshah Escape stands. Strabo is obscure on this point. He writes:—"Then follows the Heracleöte Nome, in a large island, near which is the canal on the right hand, which leads into Libya, in the direction of the Arsinoïte Nome; so that the canal has two entrances, a part of the island on one side being interposed between them." Possibly this refers to the isolated bit of desert in front of

PLATE XXIV



MODIFIED REPRESENTATION OF THE BIAHMU RUINS RESTORED.

and to the east of Lahûn, which is "a part of the island" interposed between the Bahr Yûsuf coming from the south and passing to Lahûn on the left of the island, and the Magnûnah canal or special lake-feeder, which passes on the right of the island, turns south towards Lahûn and leads into Libya in the direction of the Arsinoïte Nome.

I have consulted Smith's 'Dictionary of Greek and Roman Geography,' to find out what the editor considered to be the accepted views about Lake Mœris in 1868. Under "Mœris Lacus" I find that the views stated agree in the main with those favoured in this paper. Linant's theory is not referred to, and probably had not been heard of by the editor. The following passage about the connecting canal occurs in the Dictionary, which can hardly be made to refer to the Bahr Yûsuf as the main lake-feeder, though assumed to do so in the passage itself:—"There are grounds for supposing that ancient travellers did not always distinguish between the connecting canal, the Bahr Yûsuf, and Mœris itself. The canal was unquestionably constructed by man's labour, nor would it present any insuperable difficulties to a people so laborious as the Egyptians. If, then,

we distinguished, as Strabo did, the canal from the lake, the ancient narratives may be easily reconciled with one another and with modern surveys. Even the words of Herodotus may apply to the canal, which was of considerable extent, beginning at Hermopolis (Ashmunîn) and running four leagues west, and then turning from north to south for three leagues more, until it reaches the lake."

Now the old Magnûnah Canal, with its mouth on the river near Ashment, goes west for a little over three leagues to Abûsir-el-Malaq, and then turns *from north to south* for three leagues till it reaches Lahûn. (Plate XXI.) As it is a remarkable thing to find a canal in the Nile Valley which runs from north to south, the near agreement of these figures and directions is a remarkable coincidence, if it is nothing more.

There is another coincidence which may well be accidental, but is worth noticing. Arab tradition is, I believe, the authority for placing the mouth of the connecting canal at Ashmunîn. "Joseph collected workmen and dug the canal of Menhi from Ashmunîn to el-Lahûn."

Now the mouth of the old Magnûnah Canal, which I have been supposing may have been the canal of inflow, had one of its mouths near "Ashment." Can a misprint have been responsible for "Ashment" being changed into "Ashmunîn," or may it not have been changed during the process of handing down the tradition orally, the name of the larger town Ashmunîn being substituted when the lesser Ashment lost its importance and its notoriety after Lake Mœris ceased to be?

But all these speculations must be modified, *but not more than modified*, if what follows is a more correct view of the conditions of the Nile at the time of Herodotus.

Hitherto I have assumed that the levels of maximum and minimum Nile were the same in his time as they are now.

But it is supposed that the Nile levels at that time were about 2 metres lower than they are now, and it is necessary to consider in what way such a change of conditions would modify the views of what Lake Mœris was and did, as given in the foregoing arguments and calculations.

The supposition, or certainty, that the Nile in the time of Herodotus was about 2 metres lower in level than it is now, is based on the following observations, which Mr. Petrie has given me. He estimates that the rate of rise has been about 4 inches a century. This, he states, is shown by a

Roman wall at Tanis and by the town-level of Naukratis, both old towns in Lower Egypt. The old tombs at Memphis are now under water. At Edfu the High Nile rises shoulder high on the walls, which shows a rise of 4 inches or more per century. At Aswân (Assouan) the records of High Niles on the Roman Nilometer show that they were lower than now by an amount calculated at a rate of 4 inches per century.

There is also, Mr. Petrie adds, other evidence of the same sort, but less definite, giving the same general result.

If now we suppose the Fayûm (Lake Möeris) filled to R.L. 20·50 and emptied to R.L. 17·50, there is nothing to be changed in the calculations, except the maximum and minimum surface levels of the lake. Thus there would be a rather, but not much, larger area reclaimed and the Edwah-Biahmu bank would have been formed along the edge of the lake at lowest water, instead of in two metres of water. This modified view of its formation would seem to be more probable than that which supposed it to have been formed in water.

If, however, we suppose the lake still filled to R.L. 22·50 as a maximum, while its lowest level reached R.L. 17·50, the discharges found to have been necessary to fill the lake (under the conditions previously assumed excepting as regards minimum level), must be increased by 50 per cent., and the figures representing the return-flow be doubled.

In all probability the maximum level of the lake was somewhere between R.L. 22·50 and 20·50, and may be taken as varying from R.L. 22·00 to 21·00.

The lake may have been chiefly filled by the Bahr Yûsuf and the flood waters inundating the Nile Valley, but, to fulfil the conditions of a six months' flow-in and six months flow-out of the lake, under the new conditions supposed, and retaining a maximum lake-level of R.L. 22·50, the canal of supply would have to have its off-take from the Nile moved to a point about half-way between Beni Suef and Biba. Supposing the Bahr Yûsuf and the flood water of the Nile Valley filled this lake during the flood months and the Bahr Yûsuf ceased to flow with the end of the flood, the canal from between Beni Suef and Biba would have had to supply only about 10 million cubic metres a day to make good the loss by evaporation, if the lake-level was not to be allowed to fall below R.L. 22·50 till the return-flow to the Nile was required. But there is no reason to suppose this to have been a necessity. With a lowest level of 17·50 instead of 19·50, the

problem of the lake as a relieving and supplementing reservoir to the Nile, with houses and cultivation above its highest levels, is much simplified, and a large margin is given between R.L. 20·50 and 22·50 for increasing the volumes given in my former calculations, to render the lake a more efficient safety-valve for excessive floods, and for moderating the fall of the Nile to low discharges by giving back to it a more abundant outflow.

Accepting this view of the range of the lake-levels, we shall have to look upon the Magnûnah Canal and its branches as channels of return-flow to the Nile for the commencement of the period of outflow, which would afterwards cease to carry any discharge in summer, when the lake-level had fallen below about R.L. 19·00. For the remaining period of outflow the Kosheshah Escape branch from Abûsir-el-Malaq to the Nile and the branch to Memphis skirting the Libyan Hills, would have carried all the discharge returning to the Nile Valley.

The peculiar isolated piece of Nile desert opposite Lahûn and the cultivated strip of land between it and the main desert, through which the Bahr Yûsuf flows into the Fayûm, seems to lend itself to the regulation of the entry and exit of the Nile waters. To control the entry of the waters a regulator A and cross bank *ab* from the island desert across the Bahr Yûsuf to the main desert on the west could have been made. (See map, Plate XXI.)

The excess water, excluded from the lake by regulation on A, would have found its way along the east of the patch of desert as it does to-day.

To retain and to control the exit of the water, a regulator B and its bank *cd* might have been added, where shown on the map, or anywhere between B and the end of the narrow band of cultivation at C. There is, however, no evidence to show that such works did exist, but Strabo's statement, the presence of the Lahûn pyramid and the situation of the villages Lahûn and Manshîyah make it perhaps probable that there were some important works connected with the lake in their neighbourhood.

The reason for the peculiar alignment of the present bank *g D B c* which closes the gap into the Fayûm, is difficult to imagine, as the bank is at least three times the length it would have been, if it had been formed in a direct line across the gap. But it has suggested itself to me, that the length *Bc* may be part of the original bank *d B c*, that may have crossed from side to side of the valley of exit, and on which the villages of Lahûn and Manshîyah were built.

N

Trying to find some explanation for the alignment of the existing bank, it had also occurred to me, that the line of the bank may have followed the ridge of the bar, that would have been formed across the wider part of the entrance to the Fayûm by the high level water flowing in. This bar would, if it had existed, have been the first land to show above water on the subsidence of the floods, and may have been chosen, on the occasion of one of the repeated breaches at Hawârat-el-Maqta, as the most convenient line for forming a bank to shut out the Nile flood. But this would have been at a later date, after Lake Mœris had ceased to perform its functions of a Nile regulator.

However, I think the former supposition, that the bank *Bc* was part of an old bank, formed for quite another than its present purpose, and that the bank *gB* was subsequently made between Lahûn and the desert (perhaps when the existing old Lahûn regulator was made), a more likely explanation. The length *Bd* would have disappeared after it ceased to perform any useful function.

There may have been both, or one, or neither of the regulators *A* and *B*, but if there was a regulator at Hawârah at the head of the lake at *F*, there would have been little to be gained except additional security from the regulator *A*.

If then we suppose that the bank *cBd* and the regulator *B* only existed to collect the flood waters, and turn them into the lake, and that a regulator at Hawârah at *F* also existed to keep excess water out of the lake, such an arrangement would agree with Strabo's statement that "when the river falls, the lake again discharges the water by a canal at both orifices, and it is available for irrigation. There are regulators at both ends of the canal for regulating the inflow and outflow."

The part *Ab* of one of these suggested banks exists to-day, as a lately abandoned basin bank, with regulators in it, but there is nothing, that I know of, to show that it existed in the time of Lake Mœris. At the western desert end, *a*, of the supposed bank, stands the village Tamma. Dr. Schweinfurth says this is certainly an ancient Egyptian name, and he describes some remarkable mounds of pure black Nile earth, containing no trace of bricks, sherds, stones from buildings, or other things, which lie just to the south of the modern village in four symmetrically placed hills, containing about 300,000 cubic metres.

Possibly the ancient Tamma was in some way connected with Lake

Mœris, but the riddle of the mounds has not yet been solved. They appeared to me to be the remains of the mouth of a canal taking off from a bend of the Bahr Yûsuf, but the great height and contour of the mounds and the abruptness with which they commence and terminate are not to be easily accounted for. The alignment of the canal, if such it was, points towards the entrance valley to the Fayûm.

On the east of Lahûn village there are also some mounds of moderate height, but of short length, which are evidently the remains of two old parallel canals, both pointing in the direction of the Fayûm. The abruptness with which these banks begin and end is also remarkable.

Supposing then, that the Nile levels in the time of Herodotus were 2 metres lower than those of to-day, the conception of Lake Mœris must be modified as follows :—

The lowest level to which Lake Mœris fell in summer was R.L. 17·50 above mean sea, and it was filled to levels ranging between R.L. 20·50 and 22·50, but its level was never allowed to exceed the latter level. Probably there was a regulator and bank passing through Lahûn from west to east between the main and detached desert preventing the flow of the Bahr Yûsuf waters to the north, and so diverting them into Lake Mœris; and also another regulator at Hawârah to forbid the admission of an excessive volume into the lake (Plate XXI.). On each side of this latter regulator may have been sluices, on the right to feed a canal to irrigate during flood time the high land, between Hawârah pyramid and the present railway line, along the course of the old Bahr Wardan; and on the left to admit water into the reclaimed tract round about Crocodilopolis, perhaps along the present course of the Bahr Yûsuf, for irrigation and navigation.

The old Edwah-Biahmu-Sinrû bank, instead of having been formed in water, would have been thrown up along the edge of the water when at its lowest level. The Biahmu landing-place would have been projected into the lake to obtain a quay for embarkation and disembarkation and possibly a channel would have been dug between the two colossi, so that boats might come alongside even at low water; a channel about 2 metres deep being sufficient.

The Edwah-Sinrû bank would have been subjected to most severe wave action, and could not have stood, unless we suppose it to have been well revetted with stone on the lake face. Probably it was, but the stone has entirely disappeared, a thing not incredible, when one considers how little

has been left of the wonderful Labyrinth described by Herodotus and others after him.

But if the conclusion, that the Nile water-levels have risen at the rate of 4 inches a century, be a correct one, and if it may be assumed that the rise has been continuous and uniform in historic times, the levels at the time of the XIIth dynasty (B.C. 2500), when Lake Mœris is supposed to have been formed, would have been about $4\frac{1}{2}$ metres lower than at present. Under such conditions R.L. 23·50 would have been the highest level reached by the floods at the Lahûn entrance; and therefore, at the site of the modern Medineh, the water-level would have been somewhat lower. Such a state of things would have permitted the establishment of the town "Shad" without the necessity of any arrangements for controlling the admission of the water. To what minimum levels the Nile fell, after it had first flowed at higher levels, and how far back the change from a deepening of its bed by scour to a raising of it by deposit took place is a geological question; but if the Nile flood maximum ever fell as low as about R.L. 18·00 at the Lahûn entrance, no water would have entered the Fayûm, since the rock bed at Hawârah is somewhere about this level. (Linant's Hawârah sill at R.L. 21·00 is known to be higher than the bed of the natural channel, which runs between the village of Hawârat-el-Maqta and the Hawârah pyramid.)

Imagination thus may draw another picture of a time when, after the Fayûm deposit had been laid down by the Nile flowing at high levels, the gradual scouring of the Nile bed lowered the flood water surface to such an extent that the supply, which kept the Fayûm Lake full, was gradually shut off, until, at last, the maximum flood level falling below that of the lowest rock surface between Lahûn and Hawârah, no water would have flowed into the Fayûm, and the lake would have dried up and left the land barren for want of a water supply.

After the opposite action set in and the Nile levels rose again, the flow into the Fayûm would recommence and gradually increase century by century, until at last levels would be reached favourable to the establishment of the town "Shad" on the site of the modern Medineh.

The Nile continuing to rise, protecting banks to keep the waters of the lake, when at flood levels, from the cultivation and habitations would have been found necessary, and at last the capital itself would have been threatened by the gradually increasing level reached by the highest floods.

Then, if not before, measures to regulate the inflow and to facilitate the outflow would be taken to protect the highest parts of the province from submersion, and means such as those suggested before would be resorted to to reclaim some of the invaded lands.

Since the foregoing was written, Brugsch Pasha, a leading Egyptologist, has delivered a lecture in Cairo to the Khedivial Geographical Society on the 8th April, 1892, from which I quote the following passage, showing that the Pasha's conclusions, drawn from a study of the monuments, agree with the conclusions I have arrived at from a study of the levels and features of the ground in the neighbourhood of Hawârah.

“Nul doute que le vaste gouffre de 20–30 mètres de hauteur qui s'ouvre entre les bords occidentaux du désert de Hawara et les terrains cultivés du côté opposé est, qui, maintenant, porte le nom de “la Mer sans eau” (*Bahr-bela-ma*) formait anciennement une partie du lac Moëris. C'est ainsi que ce dernier avait acquis fortuitement une signification funéraire en rapport avec le culte des morts, qui, d'après la tradition en vogue chez les anciens Égyptiens, devaient passer en bateau le Nil ou un lac pour aborder au port de la nécropole et à l'entrée du monde souterrain. Hawara représentait depuis les temps de la XII^me dynastie le cimetière de la ville Crocodilopolis-Arsinoë, près de Medinet-el-Fayoum; les défunts étaient transportés sur les canaux jusqu'au lac, qu'ils traversaient pour arriver au port de la nécropole. Les textes que j'ai consultés lors de mon dernier séjour à Hawara, ne parlent de la terre du lac qu'en la mettant en rapport avec l'Osiris de la nécropole de Hawara.

“Un canal principal (ou si l'on veut plusieurs peut-être) conduisait l'eau du lac au pied du plateau de Hawara vers la métropole qui, à l'époque des Pharaons, s'appelait “Shad” et dont l'existence remonte au moins jusqu'au règne d'Amenemhè I^{er}, le fondateur de la XII^me dynastie. Les dernières fouilles que j'ai exécutées à Médineh, mettent ce fait hors de doute. Il paraît même que l'ancienne ville de Shad formait la résidence des rois de cette dynastie, dont les pyramides s'élèvent sur le sol de la terre du lac.”

This statement about the principal canal (or several canals), leading from the lake at the foot of Hawârah towards “Shad,” accords with my conceptions of the lake, but not with Linant's; as in *his* theory all this plateau between Hawârah and the modern Medineh, or ancient Shad, was lake, and a canal or canals could not have been made in the lake itself. If

then this fact about a canal leading from the lake at the foot of Hawârah to Shad is proved beyond a doubt, Linant's theory is disproved by Brugsch Pasha himself, though he previously states that no "savant sérieux" is opposed to it.

In this same paper, from which I am quoting, this further passage also occurs, which agrees with what I have imagined to have been the early history of the town, on part of the ruins of which Medineh now stands.

"La terre du lac, ainsi que je l'ai déjà fait remarquer, a dû exister au commencement de la XII^me dynastie, dont le premier roi, Amenemhè I^{er}, avait fondé au bord de la ville Médineh un sanctuaire au Dieu Sobk. Au delà de cette époque je ne trouve aucune trace de sa mention dans les textes de l'ancien empire: l'œuvre de l'arrosement du Fayoum par un canal du Nil doit donc être reportée au moins jusqu'à l'époque du roi que je viens de citer. Également à cette époque, la fondation d'un sanctuaire et d'un palais royal fait supposer l'existence d'une résidence, c'est-à-dire d'une grande ville à laquelle le canal Hounet fournissait ses eaux.

"Tout porte à croire que le canal fut creusé longtemps avant le XII^me dynastie, car une résidence ne s'établit pas dans un pays inhabitable ou qui venait à peine d'être arrosé. L'opinion que les rois de la XII^me dynastie doivent être regardés comme les créateurs du canal Hounet n'est plus à soutenir, le Fayoum 'la terre du lac' date certainement d'une époque de beaucoup antérieure à la XII^me dynastie, et les rois de cette maison royale, pour des raisons que nous ignorons, ont seulement choisi cette terre pour y transférer leur résidence et les temples de leurs divinités."

How this view is made to accord with the Linant Lake conception is not clear, but it is not opposed to the idea that a natural lake, connected by a natural channel with the Nile Valley, existed and made the growth of the town "Shad" a possibility before the canal was remodelled, and control of the entry and exit of the waters introduced by the engineering monarchs of the XIIth dynasty.

TRANSFORMATION OF LAKE MÆRIS INTO THE FAYÛM OF TO-DAY.

Assuming that the conception of Lake Mæris, as given in this paper, is a true one, we have now to consider how the change to present conditions in the Fayûm came about.

In the passage quoted from 'Hawara, Biahmu, and Arsinoë,' Mr. Petrie

states that "apparently under the Persians or Ptolemies the desire to acquire more land in the Fayûm at the expense of the irrigation of the Nile valley, led to restricting the inflow, and gradually drying up the lake."

Mr. Cope Whitehouse, in one of his papers, points out that Mœris, in its character of regulator and reservoir, existed chiefly for remote provinces, and therefore required for its maintenance a strong central government with sufficient administrative skill and energy to take the necessary steps and to expend the necessary amount of money to secure the maintenance of the reservoir, canal, and regulators in working order. Under a careless government, or while anarchy, or internal or external troubles weakened administration, the private interests of individuals who were on the spot to assert themselves, would have prevailed over the public claims of the Northerners, powerless to keep watch over and to insist upon their rights from the distant towns of the Delta. A corrupt Public Works Department, uncontrolled by a chief with broad views of what was desirable in the general interests of Egypt, may have permitted each chief engineer of a nome to do what seemed good in his own eyes for the profit of the particular part of Egypt in which he was the Public Works officer. If we imagine that he had scruples, there have not been absent, in the modern history of the Irrigation Department of Egypt, instances of the application of means for overcoming scruples, and, as so much else in the customs of the country can be traced back to that far past time when Lake Mœris must have been languishing towards extinction, we may also suppose that the Eastern salve for tender consciences was applied and the scruples overcome.

But whatever the cause (and there is nothing but speculation, which can help us to imagine it), at some time or other, either by a gradual or sudden process, Lake Mœris ceased to perform its offices of regulator and reservoir, which had won for it the admiration of all who visited it. Having once reached the stage when it ceased to be useful in supplementing the low Nile, there would be nothing to prevent measures being taken to exclude all water, but such as was necessary for the irrigation of the reclaimed areas. Evaporation would lower the Lake level year by year, and leave more land uncovered. Year by year the Lake would contract itself, and retire to lower levels, until it had reached the present dimensions of the modern Lake Qurûn, whose water surface at the commencement of May 1892 was 43·50 metres below mean sea-level. The rate of the lake's retreat was doubtless not uniform and continuous, but was retarded by accidents and breaches of the

barrier, raised against the Nile floods, causing a return of the water over reclaimed lands. The deep ravines of the Fayûm are nature's bold strokes on the face of the province, which record some of the victories of the water, in its efforts to fulfil the law imposed on it to find its own level, over man's endeavours to control this law.

Evaporation by itself, had its results not been vitiated by other causes, would have lowered the lake surface by about 2 metres a year, but the drainage and waste from the reclaimed area under irrigation would have retarded the fall, and breaches would probably have occasionally converted the fall into a rise. It is therefore difficult to assign dates for different levels of the lake surface, but probably the old towns at different levels around the borders of the Fayûm, so far as their dates can be fixed, will, when their levels have been correctly ascertained, throw some light on this subject.

The former manner of conducting the irrigation of parts of the province would have caused a much larger proportionate discharge into the lake, than finds its way to it at present. Considerable areas were enclosed by banks, and inundated under the Basin system, known in the Fayûm as "Malaq," in contradistinction to irrigation by small field channels, a system called "Misqâwi." The contents of these small basins, when emptied, flowed into the lake. On the south side of the Fayûm there was, until late years, a large basin known as "Hod-el-Tuyûr" (the Basin of the Birds), which was formed by building an immense wall across a fold of contour R.L. 15·00. The top of this wall is about R.L. 16·00. The bed of the basin is at R.L. 12·00, so we may conclude that, when this wall was built, the lake levels must have been at any rate below R.L. 12·00. This basin was abolished in 1886, and ordinary perennial irrigation introduced over the area formerly included within the basin limits. Since then the fall of the lake surface has been more rapid, in spite of its annually diminishing evaporating area.

The existing lake, which is the rudiment of the large lake that once filled the whole of the Fayûm depression, is called Lake Qurûn, or el-Qurn, the Lake of the Horns, or the Horn, apparently so named from a rock that projects into the lake from its west side and called "el-Qurn."

It is evident, from the levels of the rock bed underlying the Nile deposit near Hawârah, that the original course of the waters flowing into Lake Mœris (after it became Lake Mœris by introducing means of controlling its

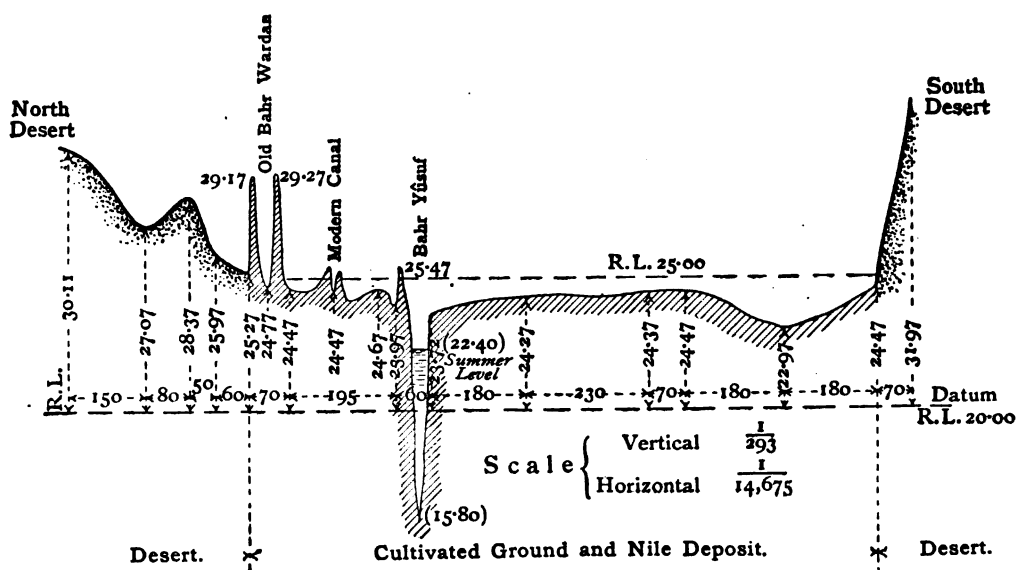
waters) must have been along the ravine which runs to the north of the modern village of Hawârat-el-Maqta. The bed of the present Bahr Yûsuf, at a point about a kilometre below that village, is rock at R.L. 21·00, and this rock joins the high desert on the south of the Bahr Yûsuf. But on the north it dips down, and close under Hawârat-el-Maqta has been found to have its original surface at R.L. 19·17, dipping still lower towards the north-east. Plate XXV. gives cross-sections of the entrance valley of the Fayûm, and also of the ravine behind Hawârat-el-Maqta.

"Hawârat-el-Maqta" signifies "Hawârah of the Breach," and round about this village lay the battlefields where many a struggle was made by man to get the mastery of the water, until he at last prevailed. Massive walls and solid banks, retaining the Bahr Yûsuf in its high level channel, and barring the passage into ravines, scoured out by previous torrents of water bursting away from control, mark the sites of many a breach, and suggest sleepless and anxious nights of hard labour for the wretched irrigation officer in charge in the days when the water seemed to have asserted its rights to flow where it pleased.

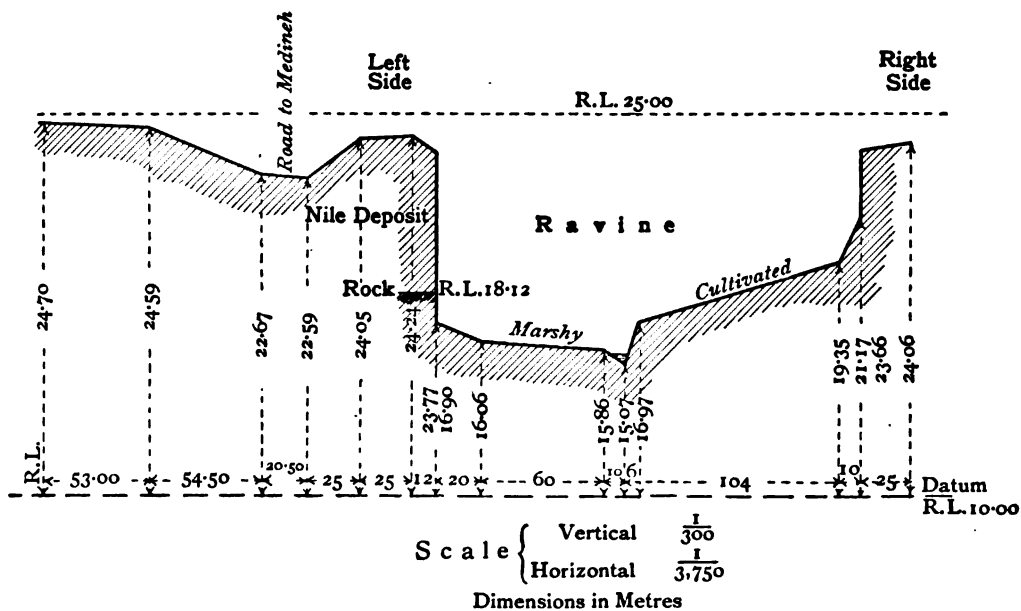
On the left of the Bahr Yûsuf are the remains of a channel, which was clearly a temporary one for carrying the water, while a breach near Hawârat-el-Maqta was being repaired. Linant Pasha tells of the occurrence of one of these breaches on the west of Hawârat-el-Maqta as late as the commencement of this century (in 1819 or 1820). He states that this breach caused much damage. An attempt was made to close it during the floods, but in spite of all that could be done, and in spite of the energy of the people employed by Mehemet Ali, it was not till after six months at the time of low water that the closure was effected. It appears that the old bridge at Lahûn (the only one existing at the time) could not be closed, when the breach occurred, probably for want of suitable closing apparatus. This breach was down-stream of the rock bed in the Bahr Yûsuf.

When the level of Lake Mœris was kept up to levels above R.L. 17·50, the regulator at Hawârah near the Labyrinth, which I have supposed controlled the entry of the water into the lake, would have admitted the flood waters freely until the lake rose to the maximum allowable, say R.L. 22·00. If then closed, and supposing the Nile levels to have been 2 metres lower then than now, the regulator would probably have been subjected to a head of about 3 metres as a maximum, but afterwards when Lake Mœris ceased its functions and the lake fell to low levels, the regulator would have had to

PLATE XXV.



CROSS SECTION OF THE ENTRANCE VALLEY TO THE FAYÛM AT THE OLD BAHR WARDAN MOUTH,
3 KILOMETRES ABOVE HAWÂRAT-EL-MAQTA.



CROSS SECTION OF RAVINE BEHIND HAWÂRAT-EL-MAQTA.

hold up a head of water equal to the depth of water on its floor, in order to exclude the water from the lake. The right and left side channels would have taken in water from above the regulator for irrigating the reclaimed tracts. The drainage of the irrigated areas would have commenced to form drainage channels, the right drainage following the bed of the original inflow channel into Lake Mœris. As the lake level continued to fall, the drains would have scoured themselves out to lower levels, and cut back. The canals too would then have breached into the deepening ravines.

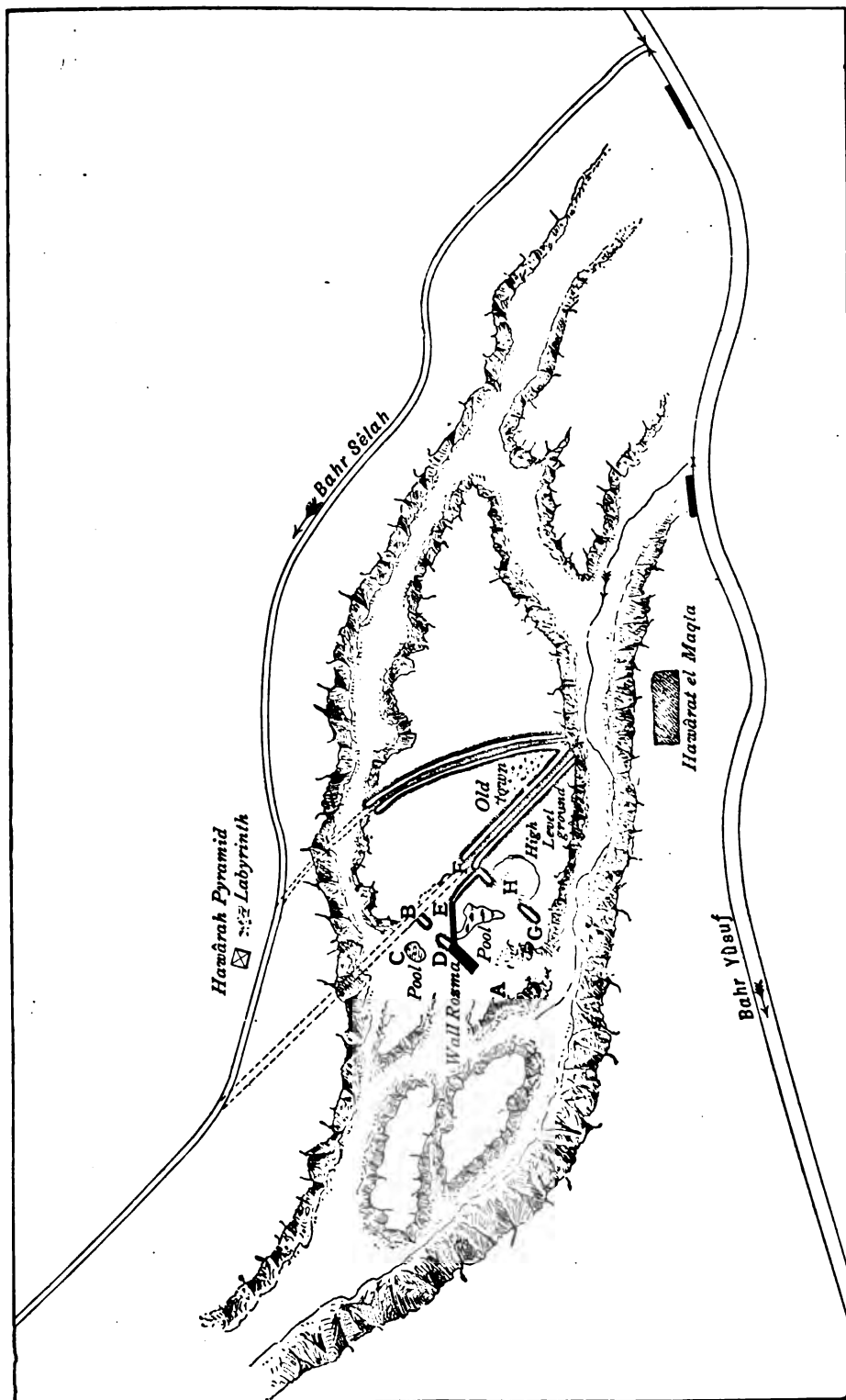
On the opposite sides of the ravine and in face of the village of Hawârat-el-Maqta, during one of my inspections, I came across the remains of two ancient canals, shown on the sketch map, Plate XXVI. Starting from the present edge of the ravine are two old canals, clearly distinguishable as such by the existing banks, which are of considerable height. In the angle between the two are the remains of an ancient town, and fragments of granite pillars. One of these fragments was part of the shaft of a large pillar of the clustered-stalk design.

Both these canals, after a few hundred yards, lose themselves in broken ground sloping down and tailing into the main ravine.

Probably the left canal was the first made, and, when it breached into the ravine on its left, the right canal was made to take its place, which in its turn also breached and found its way into the ravine. The take-off was then shifted farther up the Bahr Yûsuf to the position of the present head of the Bahr Sêlah. The dotted lines show the supposed continuations of the two old canals. To feed them, either the ravine must have been dammed below their present take-off from it, or else they must have been continued across the head of the ravine to the banks of the Bahr Yûsuf. The fact that the second diversion diverges from the old canal just where it leaves the ravine, suggests the former alternative, but more probably this was made the point of departure from the first channel so as to utilise the banks, which already existed, for crossing the ravine and avoid the necessity for making a new crossing.

Joined on to the breached end of the left canal there exist some curious vestiges of irrigation works, which have failed. It appears that there was originally an earth dam A B joining the banks of one or other of these two old canals with a point in the direction of or across the ravine. In the line of this bank where the height was greatest, was a thick masonry wall, now known as "Hêt Rozma." This wall is made of brick and rubble stone of a

PLATE XXVI.



Stanford Geog. Instab. London

SKETCH MAP OF THE GROUND BETWEEN HAWÂRAT-EL-MAQTA AND HAWÂRAH PYRAMID.

Note.—The ravines are not correctly mapped, but only sketched in to show generally how the ground is broken up.

very inferior quality, built in mortar made of lime and mud; it is 90 metres in length, 5 metres thick, and 6·70 metres high. (The top of this wall is at R.L. 21·35.) The bare end of the wall is evidently the original masonry end, as it was built, no part of the wall having been carried away when the bank, which must have joined its outer end, disappeared. The bank, of which this wall formed the centre, evidently breached and scoured out a hole, marked by the pool C below the breach. This breach was repaired by adding an inclined wall D E to the Hêt Rozma, continued by an earth bank E F to the bank of the old left canal. Again another bank G F seems to have been formed above this, and to have breached. The violent action of the water is shown by the circular hollow H, which has been scooped out of the level ground *upstream* of this breach.

I give this description to indicate what interesting problems there are to solve, or lose oneself in conjectures about, in various parts of the Fayûm Province, and especially in the neighbourhood of Hawârat-el-Maqta and the wonderful Labyrinth.

Given then the actual conditions of a considerable difference of level, continually increasing, between the water at its entrance to the Fayûm, and the lake surface, and, from an irrigation point of view, a steep surface slope to the country under irrigation, ravines would commence to form along the lines where drainage and the water, discharged by canal breaches, would collect to flow towards the lake. Wherever also an inundated area, surrounded by banks, effected the discharge of the water contained in the basin, there would be made the beginning of a ravine, which may afterwards have been utilised as an irrigation or drainage channel.

The main drainage lines of the north and south were naturally formed along the lines, where the rounded concentric contours of the central part of the Fayûm double back to run along the north and south sides of the depression, as shown in the diagram (Plate XIX.). At many points the rock being reached, further deepening of the channel was checked. The rock being close to the surface along the upper part of the course of the south main drainage line, a deep ravine has not been formed, until after the village of Miniet-el-Hêt is passed.

But the north drainage line has been scoured out and cut back to the banks of the Bahr Yûsuf itself, so that deep ravines exist within a short distance of and parallel to its present watercourse. Into these ravines a

breach would precipitate all the main canal supply, if such were to occur from negligence or from rashly permitting irrigation to be conducted from heads roughly constructed by the fellahîn in the Bahr Yûsuf banks.

Probably some small village channel, allowed to take off directly from the Bahr Yûsuf without a proper head, and used to irrigate some low lands along the slopes of the main ravine, caused a minor ravine to commence and grow, until, cutting back as far as its head, it eventually gave rise to the breach of 1820, which resulted in a widening out of the branch ravine until it attained its present dimensions.

It is, I think, evident that, when Lake Mœris ceased to be, Hawârat-el-Maqla was the key to the position and the point where the problem of the Fayûm irrigation had to be solved. It was necessary for the irrigation of the whole province, that the water-level should be held up at this point, so as to flow along the ridge between Hawârat-el-Maqla and Medineh, from which the whole province, with the exception of the land on the right of the north drainage line, was commanded. For the irrigation from the Bahr Sêlah or from the ancient canals, of which the Bahr Sêlah is the modern representative, it was necessary also that the water should not be allowed to run to low levels down the ravine at the back of Hawârat-el-Maqla. The principal operation then to be performed was to bar this ravine to the passage of the water, and to make the water flow forward along the ridge to Medineh at a high enough level at least to pass over the rocky bed, which is now found in the modern Bahr Yûsuf about a kilometre beyond Hawârah. This end being attained, the water would flow along the ridge, from the sides and end of which it would be distributed into the different branch canals covering the face of the province. Works to control the quantity of water given to each branch, and weirs to head-up the water at intervals along the canals of too rapid a slope would have been added as the want of them made itself felt.

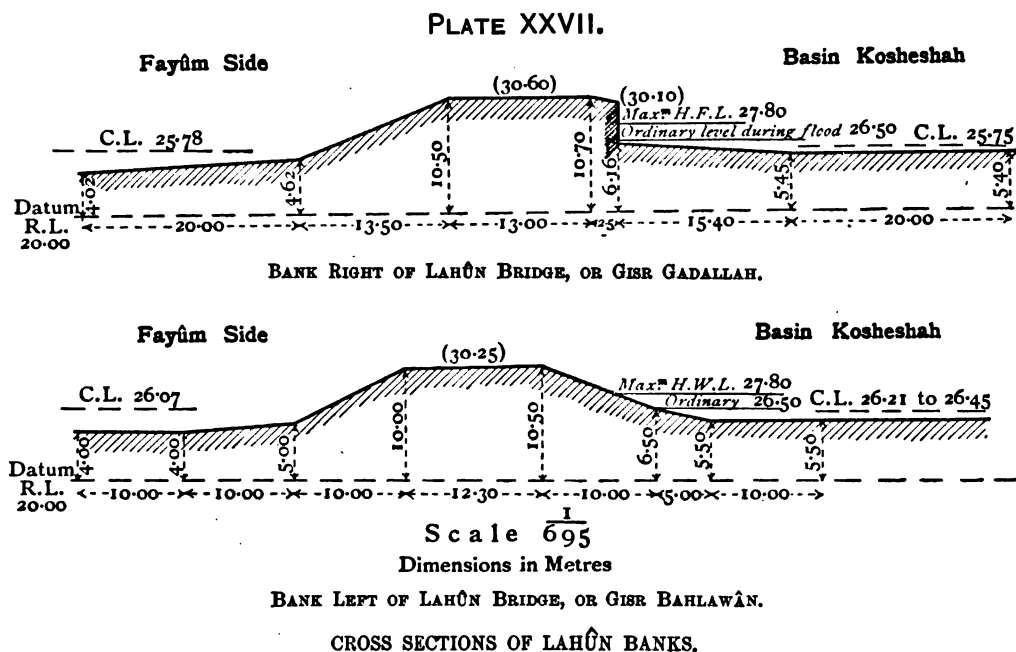
The lake level would become lower year by year, and more land would be reclaimed and brought under cultivation.

At some period of this process, probably after a breach at Hawârat-el-Maqla, or on the failure of the regulator supposed to have formerly existed at Hawârah, the Lahûn bank and its old regulator would have been formed to exclude the excess of water and to control the discharge admitted into the Fayûm. (For sections of these banks, see Plate XXVII.)

I have suggested before that the part of the Lahûn bank which runs

east and west was made in the time of Lake Mœris, and that the part from Lahûn to the south side of the gap, which crosses the Bahr Yûsuf at the old Lahûn Bridge, was subsequently made to shut out the Nile floods, when for some reason the means of regulation within the Fayûm at Hawârah ceased to be efficient.

The old Lahûn Bridge has three openings of 2·67 width, the floor level of two of them being at R.L. 21·97 and of the third at R.L. 20·72, so that this bridge could only have been constructed *after* the discharge required by



the Fayûm had fallen to the amount of its present requirements, or to even less, as the waterway is somewhat under what is desirable for the passage of 7 million cubic metres a day, the maximum discharge utilised in the Fayûm at the present day during floods.

It is evident, from the remains of canals along the north and south sides of the Fayûm, that at some time or other these slopes of the province were irrigated to higher levels than the limit of the present cultivation. On the right the old Bahr Wardan is traceable from its old mouth on the Bahr Yûsuf (Kom-el-Iswid) above the present Sêlah Head as far as the north-west corner of the Fayûm depression. It would appear that the water surface level of the Bahr Yûsuf at Hawârah must be lower now than when this canal

was under conditions favourable for irrigation. Perhaps it worked when the regulator was, as supposed, at Hawârah, and before the Lahûn bank and old bridge shut out the high-level waters of the Nile flood.

On the south side of the Fayûm there are similarly the remains of an old canal within the limits of what is now desert. This was probably fed by an aqueduct formed along the top of the Minia wall, which held up the waters in Hod-el-Tuyûr. This wall and aqueduct were breached, and though the wall was restored, the aqueduct was not, and the supply was cut off from the high-level canal. The land depending on it consequently returned to desert. Large blocks of old masonry lying prone on the ground at some distance from the present wall show with what force the escaping waters must have rushed through the breaches to have been able to transport such massive blocks to so great a distance from their original position.

CHAPTER V.

THE FAYÛM IN THE FUTURE, AND POSSIBLE UTILISATION OF THE
WADI RAIÂN.

THE subject of storage reservoirs for husbanding the flood or winter surplus waters of the Nile with the object of supplementing the Low Nile is now under consideration and *sub judice*. Mr. W. Willcocks, M.I.C.E., has been appointed Director-General of Works for the study of this subject, and his final report has not yet been made.

It has been calculated that the total of the Nile discharges for even a minimum year is more than sufficient for all the needs of Egypt, developed to its fullest extent, and the main question to decide is where the reservoir is to be made and what form it is to take.

Portions of the Nile Valley itself could be made to store the water by forming one or several masonry dams across the Nile, and the Wadi Raiân could also be made to serve the same purpose by putting it into communication with the Nile by means of a channel cut in the range of hills which divides the depression from the Nile Valley.

The discussion of the advantages of the different methods of forming Nile reservoirs does not belong to this paper, but there is a probability that a reservoir in some form will be made, and that the Fayûm will receive its share of the resulting increase of the summer water supply. Its present summer supply would probably be doubled, which would enable the province to increase the area under cotton from about 50,000 to 100,000 feddans, but would otherwise have no great effect on the province. The expansion of the present area under cultivation in the Fayûm to the lands along the north-east and south borders of the province does not depend so much on an increase to the present supply as on the construction of canals designed to carry sufficient water at a high enough level to command the lands above the present limits of cultivation. There is no want of water during Nile flood time outside

P

the intake of the Fayûm, but its present canals will not carry more than a total discharge of 7,000,000 cubic metres a day, and therefore that is the maximum allowed to pass through the Lahûn bridges.

If, however, the Wadi Raiân were to be made a reservoir, the reclamation of the lands along the south and south-west borders of the Fayûm would be made comparatively easy. What this area amounts to is rather uncertain.

In Chapter III. the conclusion was arrived at, that the Wadi Raiân depression had never hitherto acted as a regulator to control the Nile floods and supplement the Low Nile, and that its past history shows no record of useful work, so far as the irrigation of Egypt is concerned. But this fact does not affect the question of its possible uses in the future, for which its physical features and geographical position may fit it. It is a depression, separated by a short width of hill from the Nile Valley, and if filled with water up to R.L. 24·00, would become a lake, having a surface area of about 600 million square metres, and a greatest depth of 64 metres. There is no doubt that the communication could be made; the only question is, would it be worth the expense, and could not better results be obtained for the same expenditure by the adoption of other rival projects. This question is now being considered by the Ministry of Public Works.

There are four uses which the Wadi Raiân depression might be made to serve, if a communication with the Nile Valley were established.

It might be used,

- (1) As a reservoir of control for the Nile floods.
- (2) As a reservoir of storage to supplement the Low Nile.
- (3) As an area to be brought under cultivation.
- (4) As a receptacle for the drainage of the Nile Valley during the flood season.

(1) It would not make an efficient regulator for the control of the Nile floods, unless it were to be expressly reserved for this object, and its level kept low until all fear of the necessity of relief arising had passed. If it were considered necessary to provide for the relief of the Nile to the extent of 100 million cubic metres per day for 30 days, the lake, having an area (at R.L. 24·00) of 600 million square metres, should be kept at such a level as would allow of its receiving the 3000 million cubic metres without checking the inflow in consequence of its surface level becoming too high. An addition of 3000 million cubic metres to the reservoir would raise it about $4\frac{3}{4}$ metres,

allowing for evaporation for 30 days. This is about the extreme duty the Wadi could perform as a reservoir of control, if it were expressly reserved as such; but, if it is to serve this object alone, the expenditure, which would be incurred in fitting it to do so, would certainly be considered out of proportion to the benefits to be obtained. An attempt to combine the two duties of controller of Nile floods, and feeder to Low Niles would probably result in failure, as the necessity of keeping the reservoir level low to fit it to act as an escape-valve during September might make it impossible to raise the level afterwards to a sufficient height to render it an efficient feeder to the Low Nile.

(2) It would, however, make an efficient feeder for supplementing the Low Nile, if the control of the flood Nile were neglected. If connected with the Nile about Beni Suef, and also with the Bahr Yûsuf (which could continue to flow into it after the Nile ceased to do so), the reservoir could easily be filled to R.L. + 26.00. Assuming R.L. 21.00 as the level to which the water in the reservoir would fall in summer, and allowing one metre for evaporation for six months, the volume required to fill the lake from R.L. 21 to 26 would be $600,000,000 \text{ square metres} \times (5 + 1) = 3600 \text{ million cubic metres}$. From November to January, say 90 days, the Bahr Yûsuf could supply an average of 12 million cubic metres a day at least, or 1080 million cubic metres, leaving 2520 million cubic metres for the direct Nile feeder during the 90 days of flood, or an average of 28 million cubic metres a day.

The reservoir would return to the Nile Valley $600,000,000 \times (5 - 1) = 2400 \text{ million cubic metres}$. Allowing for a loss of 10 per cent. in the distributing canals outside the reservoir, we get a supply of $(2400 - 240 =) 2160 \text{ million cubic metres}$ available for irrigation.

Now 60 days is given as the critical period in Lower Egypt, when the Nile supply is generally insufficient. Subtracting 160 million cubic metres for the Fayûm, the 2000 million cubic metres remaining would therefore give an average discharge of 33 million cubic metres a day to supplement the Low Nile, and, if distributed in increasing quantities in proportion as the Nile fell, it might be so arranged as to prevent the Nile minimum discharge ever falling below 50 million cubic metres a day in the very lowest years of summer Nile.

But calculating with a period of 100 days, which is the length of the critical period for Upper Egypt, we obtain a mean discharge of 20 million cubic metres a day, which might be so distributed as to prevent the

minimum Nile falling at any rate below 45 million cubic metres a day, as for instance below :—

	Month.	Minimum Nile Discharge without Reservoir. Monthly Average.	Supplied by Reservoir.	Total Increased Discharge.	
	March	40,000,000	5,000,000	45,000,000	
	April	35,000,000	10,000,000	45,000,000	
	May	25,000,000	20,000,000	45,000,000	
	June	20,000,000	25,000,000	45,000,000	
	10 days of July ..	30,000,000	15,000,000	45,000,000	

This disposes of 1975 millions, whereas 2000 millions was the quantity calculated as being available after loss by evaporation in the lake, and by absorption and evaporation in the distributing canals outside the lake. I think, therefore, I have not overstated the capabilities of the reservoir as a feeder to supplement the Low Nile.

I have said nothing about the first filling of the lake, which is a question of no small difficulty. To fill it to R.L. 21·00, its low summer level when once in working order, would require a volume of 15,000 million cubic metres plus the quantity required to meet loss by evaporation during the time of filling.

(3) The idea that the depression might be converted into a cultivated basin is, I think, not likely to get beyond the stage of suggestion, as, with the object only of extending cultivation, the expense of connecting the Wadi Raiân with the Nile will not be incurred, since there are so many other projects of reclamation, which would need less expenditure and give a better return.

(4) The last use to which the Wadi Raiân might be put, and which has lately been suggested, is to adapt it for the reception of the drainage waters of the Nile Valley, after the basin area of at least Middle Egypt has been converted into Sêfi (summer) irrigation by means of the increased supply provided by the assumed existence of reservoirs in the Upper Nile Valley and a regulating dam at Asyût.

When all these basin lands are converted into tracts under perennial irrigation, there will be a great difficulty in the disposal of their drainage

water during the time of high flood, and the Wadi Raiân affords a possible means of solving this problem. Even though the drainage might gain on evaporation and the Wadi Raiân become eventually full, its water surface could be annually so far lowered by allowing a flow out into the Nile during the summer months, as to prepare the basin for the reception of all the drainage it would be called upon to receive during the next flood season.

It would further be possible to combine the uses Nos. 2 and 4, and make the depression serve both as a receptacle of the drainage during the floods and a reservoir to supplement the Low Nile during summer. But it might be objected that the admixture of drainage with the reservoir waters, returned to the Nile in summer, might render the river water unfit for irrigation. Supposing the drainage discharge, which must be received into the reservoir, amounts to 15 million cubic metres a day for 80 days (probably a high estimate), the total volume of drainage water would amount to 1200 million cubic metres, or one-third of the quantity of water (3600 million cubic metres) required to fill the lake from R.L. 21 to 26, or half of the 2400 million cubic metres returned to the Nile Valley. This would be further diluted by the summer discharge of the Nile itself, to which it would be added.

If the reservoir were filled to R.L. 25 during the flood months by the drainage and flood waters together, the remaining metre could be added by a canal discharging 7 million cubic metres a day for 100 days in winter, and fed from the Ibrahimîyah Canal, or a new branch of it, which would replace the Bahr Yûsuf, when the latter was converted into the main drainage line consequent on the basin lands being brought under perennial irrigation.

If then the drainage water should not be found salt enough to seriously affect the quality of the reservoir water, the Wadi Raiân might be made to serve both the purposes stated.

It has been assumed in previous notes on the subject, that such a reservoir alongside the Fayûm would be capable of giving that province its summer supply, but there would be a difficulty in the way of doing this. Under present arrangements the water-level at the end of the Bahr Yûsuf at Medineh is maintained throughout the summer at R.L. 21·70. If the level were to be lowered, lands now commanded by the water would cease to be so. The Wadi Raiân reservoir, whose level has been assumed to fall to R.L. 21·00, while a length of canal of at least 40 kilometres would be required to convey the water to Medineh, could not, during part of the

summer (after its water surface had fallen below R.L. 23·50) deliver water at the level at present maintained.

It would, probably, therefore be necessary, in spite of the adjacent reservoir, to supply the Fayûm during summer by a branch from the Ibrahimiyah Canal, but the reservoir could assist by providing for the irrigation of all the lands, now cultivated or capable of being reclaimed, on the left of the main south drainage line, and the part of the province watered by the Qalamshah Canal; that is, it would feed the Gharaq, Qalamshah, and Nezlâh Canals, and so far assist in the summer irrigation of the province.

No doubt the proximity of a lake of 600 million square metres (280 square miles), filled to a high level with reference to the greater part of the Fayûm, would affect the climate of the province, and at any rate take some of the heat out of the south winds, which blow at intervals in March and April.

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